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NEW YORK, JUNE, 1895.

EDITORIAL NOTES.

THE editor of the *American Machinist* has been conferring with "a prominent engineer," who says that a difficulty with a steam engine is to keep the cylinder hot, and, with a gas engine, to keep it cool. He therefore proposes to combine the two—the gas-engine cylinder to heat that of the steam engine, and the latter to cool the former. This recalls the scheme of an embryo civil engineer who observed that the top member of a suspension bridge was in tension, and that of a bow-string girder in compression. He therefore proposed a combination of the two principles, whereby the strains on the top member of the one would neutralize those on the other, and thus both could be dispensed with, and he would have a bridge with a lower chord alone. *That* bridge has never been built. How would it do to mix the exploded gases with the steam between the high and low-pressure cylinders of a compound engine ?

ENGINEERING papers in this country are discussing the subject of standard sizes for publications, and various recommendations are being made. Thus far the Master Car-Builders' Association is the only one of the technical organizations which has taken action thereon. The sizes they have recommended are published in each number of the AMERICAN ENGINEER in our review department. No good reason is apparent why all, or at least most, books should not be made of standard size. To accomplish this, the publishers should be called into conference. It is being discussed in English papers as well as here, and evidently the subject is one of international interest and importance. Mr. Oberlin Smith recently, in a letter to the *American Machinist*, recommends that a 24 × 36-in. sheet of paper be taken as the basis of a system, and that its subdivisions into halves, quarters, eighths, etc., be adopted as the standards of size. This would give 24 × 36 in., 12 × 18 in., 9 × 12 in., 6 × 9 in., 4½ × 6 in., 3 × 4½ in., 2¼ × 3 in., 1½ × 2¼ in., and 1½ × 1½ in.

If the covers of books were made of these sizes their projection beyond the leaves would allow for trimming. The Librarians' Association would seem to be the parties to take the initiative in this matter so far as it relates to publishing business.

SOME time ago Captain H. Riall Sankey presented a paper at a meeting of the British Institution of Mechanical Engineers. This paper was then discussed, and at a more recent meeting the subject was reintroduced by the author of the paper. He then endeavored to show that, although for many purposes the popular verdict in favor of variable expansion governing may be accepted, yet its advantages are commonly much overrated, while in some cases it has no advantage whatsoever. A number of other members took part in the discussion, which revealed a great difference of opinion. Mr. Joy, the inventor of the valve-gear which bears his name, referred to the performance of some seven or eight locomotives running at from 50 to 52 miles an hour, the conditions in each case being even. Premiums were offered to those drivers who secured the best results. One set of men worked entirely on expansion—to the highest point of expansion ; another set worked largely on throttling. The results came out almost identical. He believed that a judicious combination of the two methods, especially in electric-light engines, was to be preferred, and he anticipated that they derived the best results partly by throttle-valve and partly by expansion governing.

Professor Barr opined that the paper would afford a starting-point for many interesting experiments, stated that the right way to make trials was not to try an engine governed by a throttle-valve against a motor controlled by automatic expansion. The correct method was to take one engine and drive it neither with automatic expansion nor with throttling, but to drive it with a constant load upon the brake, and to make a series of experiments on the engine with the stop-valve throttle and the brake load adjusted accordingly.

COMPOUND LOCOMOTIVES.

IN another part of this number of the AMERICAN ENGINEER a report is published of the meeting of Mechanical Engineers, which was held on the evening of May 8, at which the subject for consideration was the much-disputed advantages and disadvantages of compound locomotives. Two very interesting papers were read, one by Mr. F. W. Dean, of Boston, and the other by Mr. C. H. Quereau, both of whom have had much experience with this class of locomotives. The authors of the papers and those who took part in the subsequent discussion —with the exception of one mechanical agnostic—were advocates of that kind of locomotives. As some one remarked, the meeting, to a very considerable extent, was a "compound love-feast." The proceedings and the arguments advanced revealed, though, what is very well known to all who have investigated the subject, that there is still a very great difference of opinion on this important subject among those who have the most abundant opportunities of getting information. The advantages and disadvantages of compound and simple locomotives were, however, set forth by the different writers and speakers in such a way as to permit of enumeration. This we will attempt to do, and will designate the various reasons for and against compound locomotives by letters, for convenience of later discussion. The advantages of compound locomotives as recited in the papers and discussion were as follows :

(*a*) Steam can be used more expansively.

(*b*) Higher steam pressure may be more advantageously utilized.

(*c*) Less wire-drawing of steam, because expansion is secured with a later cut-off.

(*d*) Cylinder condensation is diminished by reducing the range of temperature in the cylinders.

(*e*) Reheating of steam, and re-evaporation of its moisture by the waste gases is possible between the high and low-pressure cylinders.

(*f*) Steam which leaks through the piston and valve of the high-pressure cylinder is worked expansively in the second cylinder.

(*g*) Steam re-evaporated near the end of the high-pressure piston's stroke, too late to work expansively in a simple engine, is utilized in the low-pressure cylinder.

(*h*) Greater economy in the generation of steam, resulting from a lessened steam consumption, and consequent lower rate of evaporation.

(*i*) Reduced cost of boiler repairs, due to a lower rate of evaporation.

The disadvantages may be enumerated as follows:

(*m*) Back pressure on the high-pressure piston, which reduces the maximum rotative effect which can be exerted by a piston of a given size. That this is a disadvantage is shown by the fact that, in order that compound locomotives may be able to start and pull a maximum load, the compound principle must be abandoned temporarily, and such engines are worked by single expansion when they are required to exert their greatest power.

(*n*) Reduction of steam pressure in passing from the high to the low-pressure cylinders.

(*o*) Excessive compression in high-pressure cylinders.

(*p*) Greater heat radiating and absorbing surfaces in the cylinders.

(*q*) Increased weight of cylinders, pistons, intercepting valves, steam pipes, reheaters and their connections.

(*r*) Additional complexity in these parts.

(*s*) Greater weight of reciprocating parts with corresponding difficulty in balancing the engine, unless four cylinders are used, and their pistons are made to balance each other.

(*t*) In the case of two-cylinder engines, unequal pressure on the pistons on the two sides of the engine and consequent wear of wheel flanges on one side.

(*u*) Greater total first cost.

(*v*) According to Mr. Nichols, the "compound engine requires a great deal more care given to important details, and more attention in its repairs, in keeping in order, and probably considerably more expense than the simple engine."

(*w*) According to the same authority, "it requires a great deal more care and skill in running . . . and the simple engine requires less knowledge to understand."

Increased cost of repairs is also alleged for the compound engines; but that is a consequence of some of the above elements, and will not now be taken into account.

If, then, we could assign values to all these elements of advantage and disadvantage, obviously the solution of the problem would be very simple. Unfortunately this is not now possible, but it may facilitate an estimate of their value to consider them separately.

It may be stated as a rough but, for the present purpose, a sufficiently accurate estimate of the fuel expense of locomotives the country over, that they each burn about $2,500 worth of coal per year in those regions where coal does not cost more than from $1 to $1.50 per ton. If, now, we take Mr. Quereau's estimate of a saving of 15 per cent. under ordinary circumstances,

$$a + b + c + d + e + f + g + h + i = \$375,$$

and, according to Mr. Dean, the sum of these quantities is greater than $750. Of course these values would be increased in sections of the country where coal costs more than $1.50 per ton. But even if the estimates of annual saving are equal to these sums, we still must determine the value of

$$m + n + o + p + q + r + s + t + u + v + w.$$

If this exceeds $375 it will more than neutralize Mr. Quereau's estimated saving; and if the aggregate is more than $750, Mr. Dean's economy vanishes. While recognizing the great difference in the amount of saving attributed to the compound principle in locomotives by the authors of the two papers which were read at the meeting referred to, the correctness of their deduction will not now be questioned, excepting so far as they have been attributed to causes not included in that principle; the question which will be considered here is whether a saving of 15 or of 30 per cent. of fuel is sufficient to compensate for the disadvantages which have been enumerated.

The obviousness of the disadvantage designated by (*m*)—that is, the back pressure on the high-pressure piston—has perhaps blinded some and prevented them from recognizing its importance, just as we do not see the magnitude of an object which is held close to our eyes. To reduce the question to its simplest elements it will be supposed that the high-pressure cylinder on a two-cylinder compound locomotive is the same size as the cylinders of a simple engine, and that in starting steam is admitted during the full stroke of the piston; obviously if the exhaust discharges into a receiver of the same size as the high-pressure cylinder, the back pressure will be half that on the other side, and the tractive effort which can be exerted by that piston will be only half that which could be exerted by that piston if the steam was freely discharged into the atmosphere as it is by a simple engine. To get over this difficulty, one of three expedients must be adopted—higher steam pressure or high-pressure cylinders larger than those required for simple engines must be used, or, while the engine is exerting its maximum power, the compound principle must for the time being be abandoned. Obviously a simple engine can be made to exert its maximum power with greater facility than a compound engine can—a matter of great importance in a locomotive. Obviously, too, the conditions which exist with a marine or a stationary engine having a nearly constant load are very different from those prevailing in locomotive service, in which the power to be exerted varies from nothing to the maximum effort which the engine can exert.

(*n*) The reduction of steam pressure between the high and the low-pressure cylinders Mr. Dean says in some instances is 30 per cent, and in well designed engines only 8. In simple engines it is *nil*.

(*o*) Excessive compression in high-pressure cylinders is due to the fact that the enclosed steam has a greater tension on a compound engine than it has on a simple one, although the period of compression may be shorter in the one cylinder than it is in the other.

(*p*) The increase of heat radiating surface in the cylinders of a compound engine is an obvious consequence of their larger size. The same thing (*q*) is true of their weight. The latter increase would give a simple locomotive an obvious advantage, inasmuch as it would permit the excess of weight in cylinders, etc., to be put into the boiler or other parts of the simple engine. By this expedient the simple engine would have an advantage which is inherent in that system.

(*r*) The complexity of the compound engine, whatever it may be, obviously is to the extent to which it exists a disadvantage, the effect of which would be greater cost of repair and a diminution of service of the engine.

(*s*) The evil of increased weight of reciprocating parts now needs no comment, and so far no advocate of the compound system has claimed that they can be made as light for big cylinders as they can be for little ones.

(*t*) The unequal wear of flanges has been observed on some two-cylinder compounds. Whether the evil is inherent in that plan of an engine or a defect in the design of those on which it was observed there are perhaps now no certain means of knowing.

(*u*) The greater first cost of compound locomotives is a fact which cannot be ignored, and in no case has their cost been

reduced to that of a simple engine of corresponding capacity. The disadvantages designated by (*v*) and (*w*) are also important, and mean that more care and cost must be expended on compound than on simple engines. This represents money, and probably with a given amount of skill and expenditure such engines would not be in service as many days in a year as simple engines.

With reference to the advantages of reheating, which Mr. Dean has so skilfully applied to his compound engine, it is doubtful whether it can be claimed as an advantage of the compound system, as it is quite possible to superheat the steam of simple engines, and the results would be substantially the same. A reheater and a superheater are substantially the same thing. Doubtless the application of a feed-water heater would increase the economy of compound locomotives, but it would hardly be fair to claim whatever gain resulting therefrom for the compound system, as feed-water heaters may be just as advantageously applied to simple engines as to those of the compound type.

It is admitted, too, that many compound locomotives have been built which were badly designed, and that the system should not be judged by the failures, but by the successes. It would not be wise either to come to any final conclusions with reference to the relative advantages of the two types of engines from the experience of the past alone. It is but probable that in a new departure as radical as that which is involved in the construction of compound locomotives the highest degree of success should be reached with the first experience, and the failure of some badly designed locomotives built on this system is by no means conclusive. Evolution and development will be required here, as it is in all other advancement. But, on the other hand, it is folly to close our eyes to the difficulties which must be met, and it certainly would be unwise to delude ourselves by facts which are not true and arguments which are fallacies.

It is to be regretted, we think, that the committee on locomotive tests appointed by the Master Mechanics' Association laid out such an extended, pretentious and expensive plan as they did, and which involved the expenditure of a large amount of money, which it was impossible to obtain in the hard times which are behind us, and which are improving so slowly. A simple coal test would be possible on almost any road, which would throw light on this much-disputed subject, and which would not cost more than a few hundred dollars. Let the committee appointed to conduct the test select the best compound and the best simple engine of like class and weight, and arrange to haul trains on some road where there would be little likelihood of delays. Let them begin with a light load, and gradually increase it from day to day, and weigh the coal and trains accurately, being careful that the same quality of fuel is used on each engine. It would be important, of course, that the very best simple engine should be tested against the best compound; not, as has so often been the case, a good compound against a poor simple engine. The tests to be made under the general direction of the committee, they to employ a competent person to conduct them. It would interfere but little with the traffic of a road, and a few hundred dollars would cover the cost. The use of dynamometers, pyrometers, thermometers, calorimeters, revolution-counters, indicators, and other scientific instruments of high degree could be deferred until after the important fact was ascertained which engine was the most economical in coal. All that would be required would be to weigh it and weigh the trains and record the time, leaving other and more highly scientific observations for future tests. If the committee should have such a series of tests made, and make a clear and intelligent report thereon, and then indicate what further tests it would be profitable to make, probably there would then be no trouble in getting the money required; but it was not unnatural, when one roving compound committee applied to railroad companies for a sum as large as $15,000, to be expended by another similar committee whose measure of responsibility for the expenditure was not very definitely stated, it was but natural that the purse-strings of the railroad companies should be tightened and the committee turned away moneyless. What is wanted is a little money, a great deal of intelligence, and more light on this disputed question.

NEW PUBLICATIONS.

History of the Rensselaer Polytechnic Institute, 1824-94. By Palmer C. Ricketts. New York: John Wiley & Sons. 193 pp., $5\frac{3}{4} \times 8\frac{1}{4}$ in.; $3.

The Rensselaer Polytechnic Institute, Mr. Ricketts tells us in his preface, was "the first school of science and the first school of civil engineering to be established in any English-speaking country. The history of this institution will therefore be of very great interest, especially to the many graduates of that school. The book before us has evidently been prepared with a great deal of care, is well printed in large, clear type, and quite fully illustrated with portraits of the founders and views of the inside and outside of the buildings, students at work, apparatus used, etc. A list of names of trustees, instructors and graduates, and a good index completes the volume.

Duty Trial of a Pumping Engine for the Louisville Water Company, Louisville, Ky. Built by the I. P. Morris Company; Owned and Conducted by the William Cramp & Sons' Ship & Engine Building Company. Philadelphia: 63 pp., $5\frac{3}{4} \times 9$ in.; 4 folded plates.

This pamphlet is a reprint of a report of a contract trial of engine No. 3, made by Dexter Brackett and F. W. Dean to the Louisville Water Company, and also two papers read by Mr. Dean before the American Society of Mechanical Engineers at their meeting last December. One of these was on a trial of the same Leavitt Pumping Engine at Louisville, Ky., and the other of a compound engine built by the Wheelock Engine Company, of Worcester, Mass., for Messrs. B. B. & R. Knight, of Providence, R. I. The discussion on the latter paper is also given. As these papers have been published in the Transactions of the society, an extended review is not called for. The report and papers are, however, put in convenient form for reading and reference, although some more satisfactory engravings of the Louisville engine would be most desirable.

The Slide-Rule: *A Practical Manual.* By Charles N. Pickworth. New York: D. Van Nostrand Company. 56 pp., 5×7 in.: 80 cents.

This little book is intended to explain the principles and uses of the Gravêt or Mannheim type of slide-rule, which has been in general use in Germany and France for a long time, although it is but little known to English-speaking engineers. Probably to most engineers and mechanics the slide-rule is a mystery; but if what those who understand how to use it say is true, it can be made a valuable adjunct of any engineer's equipment.

The slide-rule, the author says, "may be defined as an instrument for mechanically effecting calculations by logarithmic computation. By its aid various arithmetical, algebraical, and trigonometrical processes may be performed with ease and rapidity, the results obtained being sufficiently accurate for almost all practical requirements."

The principles and construction of the instrument are first described very concisely and clearly, and its application to the solution of various arithmetical and other mathematical problems is shown. Probably most persons who have never given the subject attention will be surprised at the variety of operations which can be performed with a slide-rule. Besides ordinary arithmetical calculations a number of problems in mensuration are given, which can be quickly solved by this means. A few examples of other problems will indicate the variety of uses to which it can be put. Among them are the following:

To find the weight in pounds per lineal foot of square bars of metal.

Set index B to weight of 12 cub. in. of the metal on A, and over the side of the square in inches on C read weight on pounds on A.

To find the centrifugal force of a revolving mass in pounds. Set 2,941 on B revolutions per minute on D; bring cursor to weight in pounds on B; index of B to cursor, and over radius in feet on B read centrifugal force in pounds on A.

Given the stroke and number of revolutions of an engine per minute, to find the piston speed.

Set stroke in inches on C to 6 on D, and over number of revolutions on D read piston speed in feet per minute on C.

The application of the slide-rule to the solution of problems relating to steam boilers, speed ratios of pulleys, etc., belts and ropes, spur wheels, screw cutting, strength of shafting, moments of inertia, hydraulics, electrical engineering, and a variety of trigonometrical calculations are described.

To our younger readers the book may be commended; and it is evident that comparatively little study of it will give them an additional equipment which would materially add to their capacity for usefulness.

NYSTROM'S POCKETBOOK OF MECHANICS AND ENGINEERING. *Revised, Corrected and greatly Enlarged, with Addition of Original Matter.* By William Dennis Marks. Twenty-first Edition further Revised and Corrected by Robert Grimshaw. Philadelphia: J. B. Lippincott & Company. 675 pp. 4 × 6½ in.

As this is the twenty-first edition of this book, it may now be said to be of age. At any rate, a book which reaches a twenty-first edition must have merits which few books have. It is, however, about as difficult to point out these as it is to review a dictionary. One primary merit which it has is a good index, which, of course, is doubly essential in a book of this kind. In the printing of the book, however, the publishers, it is thought, have hardly maintained the high standard which usually characterizes their work. Take, as an example, page 34. The plate from which this was printed is decrepit, and the press-work would do discredit to a country office. Some of the engravings, too, ought to be replaced with new ones. In these days of cheap engraving there can be no sufficient excuse to use ancient illustrations in a book of this kind. It may also be remarked that the locomotives and cars illustrated on page 157 are superannuated.

Probably there is no part of a book of this kind which the users of it will refer to oftener than to the tables of circumferences and areas of circles. These tables in the book before us are combined in one. In most other similar books the circumferences and areas are given in separate tables. The columns of circumferences are headed with a circle, the inside area of which is unshaded, while the columns of areas have circles at the top which are shaded. A glance at the heading thus indicates at once whether the column contains the circumferences or areas of circles, and thus prevents errors, which have sometimes been productive of serious results. The whole book is very conveniently arranged for reference, and doubtless many to whom "Nystrom" has been a constant companion for many years will welcome this volume in a new dress.

THE SCREW PROPELLER AND MARINE PROPULSION. By I. McKim Chase, M.E. New York: John Wiley & Sons, 53 East Tenth Street. 8vo, cloth, pp. 223, $3.

It is refreshing to a marine engineer of the old school to open the pages of this book and find these important subjects of his profession clearly and conclusively treated, without the use of fatiguing formulæ of the higher mathematics that are so formidable an obstacle to the class of students to whom this book will be of most value.

The author has had a wide experience in the laying out and construction of screws, and he gives to the reader the results of this experience in a manner as plain and practical as the conventional pike-staff. He carries his subjects far beyond this, however, and discusses thoroughly the principles that underlie the action of the screw.

He ventures into no speculations based on theories, but gives a very complete *résumé* of the conclusions of the best reasoners on the subjects of which he treats. In the preface to his second volume, Isherwood says: "The whole science of engineering rests simply on direct facts."

In no part of marine engineering is this more true than of the screw propeller. All improvement in the efficiency of this instrument has been brought about by processes purely tentative; it has been a long succession of trying, of essaying.

Our author agrees in this when he says: "The best that can be done is to observe the practical results of screws in actual operation, and to follow the dimensions of those which give the best results under the nearest conditions to those to which the one under consideration is to be subjected." These remarks, however, need not be understood as denying "the utility of well-framed hypotheses, which is very great when they are applied with sagacity and controlled by caution." But well-digested data seems to be the only sure guide in the designs of screws; and unquestionably a very large majority of those in use were absolutely so designed. This should not deter the student from a study of principles; a knowledge of them will enable him to arrive at sound conclusions from collected data, and prevent his ploughing in over-garnered fields, which have never grown anything but weeds. The author gives the results of performance of the screws of a large number of naval vessels, going as far back as the case of the *Iris* (whose vagaries of performance puzzled the engineers of her day), down to those of the ships of our new navy, of which there is very accurate and reliable record. Of the screws thus referred to, full detailed drawings are given, as well as of many others.

The elements constituting the chief resistance encountered in ship propulsion are discussed in a clear and simple manner, to which easily comprehended illustrations add lucidity. The peculiarities of jet propulsion are plainly set forth, and its limitations demonstrated.

Some of the other subjects treated are: Screws of Various Character; Drawings of Screw Propellers and their Construction; Stream Lines; the Position of the Screw; Causes of Vibration; Material best Suited for Blades, etc. In the appendix much valuable information is given.

We believe we risk nothing in asserting that this is the best practical work on the screw and the conditions that affect its action ever published. It will be a great aid to the student in marine engineering, whether he is storing up knowledge in a technical school, or in his own way after his day's work is over. It is well printed on good paper, substantially bound, and all the illustrations are clear and easily understood. The young reader should be cautioned against an error which has converted "stream lines" into "steam lines."

A MANUAL OF INSTRUCTION FOR THE ECONOMICAL MANAGEMENT OF LOCOMOTIVES, FOR LOCOMOTIVE ENGINEERS AND FIREMEN. By George H. Baker. Chicago and New York: Rand, McNally & Co. 116 pp., 4¾ × 6¼ in.

In his introduction the author of this little manual says its object is "to properly instruct engineers and firemen in the economical management of the engines and use of fuel." It belongs to that class of literature which the authors like to call "practical," and which usually has some marked characteristics.

It cannot be said usually that one of these is the clear exposition of scientific principles. Therefore the value of such books is seldom found in that department, but generally in the directions which give the writers' experience in doing things which they have been accustomed to do. The little volume before us is an illustration of this. The chapters on Heat and Combustion can hardly be regarded as models of lucidity or of very complete explanations of the scientific principles relating to these subjects, but probably few engineers and firemen could read the directions for the management of fires and running locomotives without being benefited thereby.

The book has only a few illustrations, whereas it ought to have many, as the graphic form of instruction is generally more effective than that which is merely verbal. The engraving on the cover is an illustration of this, which gives views of a lump of coal, actual size, weighing a quarter of a pound. This, it is said, represents the quantity of coal which is *usually wasted per second* when steam is blowing off from the safety-valve. If a mischievous boy was sitting on a tender and throwing off lumps of coal of this size at the rate of one per second, probably most observers would feel like kicking him. Those who are made to realize the waste from blowing off steam will perhaps feel a similar inclination to kick the fireman when the safety-valve of his engine opens, although it might not be so safe to gratify that inclination in the case of the fireman as it would be on a boy.

The book is without an index, which, in New England parlance, "hadn't ought to be."

THE STEAM ENGINE AND OTHER HEAT ENGINES. By J. A. Ewing, M.A., Professor of Mechanism and Applied Mechanics in the University of Cambridge. New York: Macmillan & Co. $3.75.

Some years ago Professor Ewing prepared the article on the Steam Engine for the *Encyclopædia Britannica;* now he presents this excellent book which has been developed from the material then prepared. The book is naturally much more expanded than the encyclopædia article, and has, of course, been written entirely anew. It retains the combination of clearness and compactness found in the original article, together with a thoroughly sound treatment of the subject. In just 400 pages, including tables and index, there is given a discussion of the thermodynamics of air and saturated steam; the theory of the steam engine, the hot-air engine and the gas engine; the action of steam in the actual engine; the effects of superheating, jacketing and compounding; methods of test-

ing and tests on the steam engine; valve gears, governors, and the action of reciprocating parts; steam boilers; and forms of steam engines.

Of course something must be sacrificed in so compact a treatment of so many subjects on which many entire books have been written, but the choice of methods and the proportioning of space are met so as to give a complete and well-balanced whole. Adverse criticism of details must be in the main an expression of a difference of opinion. One may, for example, question the necessity of an introductory history of the steam engine taking some 30 pages of the volume.

The treatment of the thermodynamics is simplified by confining it to air and saturated steam, by accepting the scale of the air thermometer at the outset, by assuming the internal energy of a gas to depend on the temperature only, and by a special treatment of the specific volume of superheated steam. All these devices are legitimate; the only effect is to narrow the work; but that is the effect desired.

The author accepts Rowland's determination of the mechanical equivalent of heat, namely, 778 instead of the conventional 772, from Joule's earlier determinations. He does not accept Rowland's determination of the specific heat of water—an inconsistency that is not uncommon with writers on thermodynamics. Considerable use is made of the temperature-entropy diagram, which deserves more attention than has been given to it in America.

The author gives a judicious statement of the present state of our knowledge of the behavior of steam in the cylinder of an engine and the effects of superheating, jacketing and compounding. The plain slide-valve easily receives a brief and yet a complete treatment; more complicated gears like link motions and radial valve gears are explained only in a general manner. The discussion of governors gives a correct idea of the principles and the action of several types. A very elegant treatment is given of the dynamic effect due to the reciprocation of the piston and the parts moving with it. The action of the connecting-rod is, however, considered too complex for more than a general treatment.

It is to be regretted that the chapter on boilers does not give a better discussion of fuels and combustion—subjects which are at once important and susceptible of a clear and brief treatment. The author, however, considers the boiler only as an adjunct, and not improperly confines his work to a description of a few typical forms.

The book is completed by a chapter on the forms of steam engines, including the steam turbine, and a chapter on gas and oil engines.

Indicator Diagrams and Engine and Boiler Testing. By Charles Day, of the National Boiler Insurance Company, Manchester, England. Manchester, England: The Technical Publishing Company, Limited. 205 pp., $4\frac{3}{4} \times 7\frac{1}{4}$ in.

To a reviewer an author's preface usually indicates the aim he had in mind when he wrote his book. In the present instance the writer of the book before us says that "the purpose of the first portion is to explain the construction of different kinds of indicators used, and show their advantages and disadvantages, also to explain clearly the general principles on which the interpretation of indicator diagrams is based."

The second portion of the book relates to the Testing of Engines and Boilers, the information relating to which is scattered very widely, and in some cases is difficult of access. The author has, therefore, aimed to give very explicit and full directions for making such tests, which he modestly says he hopes will be of service to engineers who have not had previous experience in this direction. It may be said that he has succeeded admirably in what he has aimed to accomplish, and has given to engineers a book of very great value. It is not written either in that enigmatical style which, unfortunately, is so common in many technical books of the present day, but everything is explained with the utmost clearness, and the writer has not felt—or if he has, he has resisted—the temptation to display his knowledge of mathematics. The whole book is delightfully clear, and the reader soon acquires the feeling that the author is describing what he has actually done, and not merely what he has been reading or speculating about.

The first chapter is on the Development of the Indicator, which contains a brief sketch of its beginning, with Watts' invention, and goes on to describe the instruments which have since been and are now made by different manufacturers. These are illustrated with very clear engravings, showing the construction of the different instruments, and their respective defects and advantages are pointed out.

The second chapter is on Reducing Gears for Indicating, and describes the various methods of reducing the motion of the engine piston and imparting a coincident movement to the indicator card. Various methods of attachment of cords, levers, pipes, and cocks are described with critical remarks, pointing out their good and imperfect features.

Chapter III is on the Forms of Indicator Diagrams, and gives an admirably clear exposition of how an indicator diagram is made and how its form is produced by the varying pressure in the cylinder, and thus reveals the tension of the steam in the cylinder during the whole period of the stroke of the piston. The relation which the pressure on the piston should bear to its acceleration and retardation is also explained, although perhaps not as fully as the complexity and the importance of the subject demand.

Chapter IV is on Steam-Engine Valves and their Influence on Indicator Diagrams.

Chapters V, VI and VII are on Defective Indicator Diagrams, which most experienced engineers will find very interesting. Their interest, too, will be increased by the remark in the preface that "the illustrations are exact reproductions to a smaller scale of diagrams actually taken." A large number of such diagrams are given, having all kinds of distortions, and illustrating a great variety of defects, which are explained so clearly that the acquisition of an understanding of them is a pleasure instead of being reached only through much mental travail, as is so often the case on reading literature belonging to this class.

Chapter VIII is on Multiple-Expansion Engines, and describes the method of taking and combining the indicator diagrams.

The second part of the book is on Testing of Engines and Boilers, the greater portion of it being devoted to the latter. In making such tests, the author gives the following list of the principal observations which should be made:

(*a*) Measurement of coal and ashes, and collection of coal samples.
(*b*) Measurement of water.
(*c*) Pressure in boiler.
(*d*) Height of water in boiler.
(*e*) Temperatures of feed-water, air entering furnaces, and gases leaving boiler; also temperature in furnaces if possible.
(*f*) Analysis of coal.
(*g*) Collection of samples of flue gases and analysis of same.
(*h*) Testing dryness of steam.
(*i*) Height of barometer and state of weather.

The method of making and recording these observations, and the apparatus required is then fully described and illustrated. In no other publication will the reader find this information so fully and clearly elucidated. For the purpose of measuring water a system of tanks is illustrated, which will be a great help to any one undertaking such work.

Some simple methods of analyzing coal are also given, which may be used by a person with little or no chemical knowledge, although the author recommends that a chemist be employed for such work.

The directions for the collection of samples of flue gases, and the analysis of them, and the illustrations and description of the apparatus to be employed are also excellent. For testing the dryness of steam, a variety of calorimetres are shown and explained, and their relative advantages and defects pointed out.

In but one instance has the author failed to explain the subject treated of so as to leave the reader in a state of foggy ignorance. On page 158 he refers to the use of the "economizer," which, he says, "we will assume to be of the ordinary Green's type." Unfortunately many of his readers in this country have only vague ideas of what he means by an "economizer," and hardly any know what Green's type is. An engraving of it, with a brief explanation, would have helped American readers materially.

Of the observations to be made in testing engines he gives the following partial list, which he says may be extended or curtailed to suit the circumstances of each case:

(*a*) Indication.
(*b*) Counting of speed.
(*c*) Reading of various pressure and vacuum gauges.
(*d*) Temperature of injection and hot well water.
(*e*) Measurement of water leaving all cylinder and jacket drains, and leaking at any joints or glands.
(*f*) Determination of frictional resistances.

Brief descriptions of the methods of making all these observations are given.

The last chapter is on the calorific value of coal, which is followed by several appendices, one giving blank forms for balance sheets of boiler and economizer, and another a list of the principal results which can be determined from the observations described in the book. This is followed by an elaborate table of "piston constants" for determining the I.H.P. per pound of mean pressure on piston, which will be

found very convenient if the horse-powers of different kinds of engines must often be determined.

The book can be highly commended, as it is altogether the best book on the indicator and on engine and boiler-testing that has thus far been published. It is fairly well printed, and while the illustrations are not of superlative excellence, they are all very clear, and serve their purpose, perhaps, as well as they would if their artistic execution was better.

Motive Powers and their Practical Selection. By Reginald Bolton. New York: Longmans, Green & Co. 257 pp., 5 × 7½ in.

The problem of the selection of a motive power suited to certain conditions is often a matter of great perplexity to those who have little or no technical knowledge of the elements which should determine what kind of motive power should be used. In his introduction the author says that "it has appeared to him that a compilation or a condensation of the facts that go to settle these questions in the hands of an expert would prove of wide value not only to his class, but may be made sufficiently simple to be of a practical use in those numerous cases where these questions have to be solved by those on the spot without technical aid." He says, further, that he has, therefore, aimed, in writing the book under review, "with the double purpose of condensing and arranging these facts and figures for the easy reference of engineers and for the ready comprehension of the non-technical."

The method which he has adopted may be described by a brief review of the chapters on steam boilers. He begins by classifying them into internally and externally fired boilers. He then gives an excellent dissertation on the "power of boilers," and points out that it is "indicated by their capacity in pounds of water turned into steam per hour." He then explains that to evaporate a given amount of water in a given time a certain amount of grate area is required to burn the requisite amount of fuel, and so many square feet of heating surface are required to absorb the heat developed by the combustion of the fuel. He also points out that steam raised in a boiler may be economically or wastefully employed, and that an identical boiler with a poor engine may be ratable at an entirely different H.P. to what it would be when working in conjunction with a better motor. He then enumerates different classes of engines whose consumption of steam varies from 40 to 15 lbs. of steam per H.P. per hour. The amount of grate surface and heating surface required in different classes of boilers per pound of water evaporated per hour is then given, and is as follows:

	Grate, Square Feet.	Heating Surface, Square Feet.
Lancashire boilers	.008	.234
Cornish "	.014	.33
Locomotive type boilers	.0071	.15
Externally fired tubular boilers	.008	.266
Marine or Scotch boilers	.006	.222
Water-tube "	.008	.25

It is then explained that to ascertain how much grate and heating surface will be needed for a given engine, we must know its H.P. and the quantity of water which it consumes per H.P. per hour, and by multiplying these and the figures given above we will have the grate area and heating surface required in any of the types of boiler enumerated, and for an engine whose rate of water or steam consumption is known. A table is constructed from these data for different types of boilers and engines, from which the amount of grate and heating surface can be readily ascertained. Some formulæ relating to the proportions of boilers and a statement of "essentials for good boiler work" are given. This is succeeded by some short chapters on the different types and costs of boilers. All through the book very full information concerning the cost of the various kinds of plant described is given. In fact, fully as much commercial as engineering information is given.

The book is subdivided into short chapters, which contain discussions and data concerning Manual, Animal, Wind and Water Power; Water-wheels; Tidal Action; Floating Mills and Water-wheels; the Pelton Wheel; Turbines; Steam Power; Boilers; the Power of the Expansion of Gases; Oil Engines; Vapor or Gasoline and Hot-air Engines; the Storage of Power by Electricity and Re-use of Same; and Shafting and Belting.

To a very great extent the data given is reduced to tabular forms, which adds greatly to its convenience for use.

For persons called upon to decide what kind of power should be used under given conditions, and to engineers generally, the book will be very useful, as the information which it contains—and there is a great deal of it—can nowhere be found in so condensed a form.

BOOKS RECEIVED.

Operations of the Division of Military Engineering of the International Congress of Engineers, held in Chicago last August, under the auspices of the World's Congress Auxiliary of the Columbian Exposition. 982 pp., 5¾ × 9 in. Washington: Government Printing Office.

The Mechanical Engineers' Pocket-Book. A Reference-Book of Rules, Tables, Data, and Formulæ, for the Use of Engineers, Mechanics, and Students. By William Kent. 1,087 pp., 4 × 6¼ in. New York: John Wiley & Sons.

Souvenir Brotherhood of Railroad Trainmen. Galesburg, Ill. 20 pp., 6 × 9 in.

This is a highly ornate publication, which gives a history of the brotherhood and its work, portraits of its officers, views internal and external of its headquarters in Galesburg, description of its journal, etc. It will interest the members of the brotherhood and their friends generally.

TRADE CATALOGUES.

In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste-basket all catalogues that do not come within a very narrow margin of these standard sizes They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.

STANDARDS:

For postal-card circulars	3½ in. × 6½ in.
Pamphlets and trade catalogues	3½ in. × 6 in.
	6 in. × 9 in.
	9 in. × 12 in.
Specifications and letter-paper	8½ in. × 10¾ in.

Crawley Combined Steam Jacket, Feed-water Heater Filter, Purifier, Oil Extractor and Condenser. Manufactured by the Milwaukee Boiler Company, Milwaukee, Wis. 12 pp., 3½ × 6 in. [Standard size.]

This little publication describes the Crawley feed-water heater, which is illustrated by a sectional view on the first page, and is described and its merits set forth on the pages which follow.

Union Grease Company. Manufacturers of Lubricants for Steam and Electric Railroads and Steamships and all Heavy Machinery. Boston, Mass. 16 pp., 6 × 9 in. [Standard size.]

The merits of grease have probably been the subject of more trade eloquence than any other article which commercial men have to sell. It is, therefore, with a little surprise that one finds a pamphlet devoted to the exposition of the merits of a noted article of this kind; is written in a very temperate key which inspires confidence by its modesty. The characteristics of the grease manufactured by this company are set forth, directions for its use are given, and interior views of the works, showing the methods of its manufacture, are given, and the pamphlet ends with testimonials and a list of the users of the lubricant.

The Sterling Gasoline Traction and Portable Engines. Manufactured by the Charter Gas Engine Company, Sterling, Ill. 8 pp., 5¼ × 6¾ in. [Not standard size.]

The use of gasoline for traction engines is comparatively new, nevertheless the Charter Gas Engine Company have evidently devoted a great deal of skill and time to the designs of the traction and portable engines which are illustrated by excellent woodcuts in the circular before us. The description of these admirable machines seems to be too meagre to satisfy the mind of an engineer who is athirst for information about

them. The engravings, too—which are admirable—have hardly had justice done to them in the printing. They show plainly that the engines were designed by a master of the art, and the testimonials sent with the circular referred to will be weighty evidence of their efficiency.

SKETCHES OF WONDERLAND PENETRATED BY THE NORTHERN PACIFIC RAILROAD. By Olin D. Wheeler. Northern Pacific Railroad, St. Paul, Minn. 108 pp., 6¾ × 9⅜ in. [Not standard size.]

There seems to be hardly any limit to the cost and elaborateness of the guide-books which railroad companies find it to their interest to issue. The one before us gives a very complete description of the country traversed by the Northern Pacific Railroad, and many very interesting views of the wonderful scenery along its line. It begins with St. Paul and Minneapolis, the main eastern termini of the line. A description is then given of the Lake Park region of Minnesota, with views in the Detroit Lake region. The Red River Valley, the Rocky Mountains, and their vicinity are described, with a number of excellent views. This chapter is followed by a description of the Yellowstone Park, which is also fully illustrated with views of the wonderful geysers, mountains, places and characteristics of the scenery along the line of the road. An excellent map of this region will also enable the traveller to know "where he is at." After this comes a description of Mount Rainier, and an account of its ascent by a Northern Pacific party. Many excellent views of the mountain and places in its vicinity accompany the description.

Among the other admirable engravings is one general view of Portland, Ore., with buildings in and scenes near it. The closing chapter is on Alaska, and it ends with a map of the line of the road. The mechanical work of the book is in every way excellent.

"ELEPHANT BRAND" PHOSPHOR-BRONZE AND OTHER ALLOYS, *their Qualities and Applications*. The Phosphor-Bronze Smelting Company, Limited, Philadelphia, Pa. 19 pp. 4 × 6 in. [Not standard size.]

In their little pamphlet the publishers have set forth the nature, qualities, and uses of phosphor-bronze, of which they are the original manufacturers in the United States. The different qualities of the metal which the company make are designated by letters, and the following is a list of their uses:

QUALITY. APPLICATION.

A. For parts of machinery subject to constant vibration. Very tough.

B. For general machine casting: pinions, cog wheels, trolley wheels, propeller screws, hydraulic press and pump work, piston-rods, screw bolts for steam cylinders and hardware. Very tough and hard, and especially recommended to resist crystallization and corrosion.

C. For valves, cocks, cylinder linings, etc. Hard and durable in resistance to wear and corrosion.

D. For valves, pumps, plungers, slides, steps, etc. Nearly as hard as steel.

E. For bearings of heated rolls, valves, etc. Very hard.

F. For bells, steam whistles, etc. Harder and stronger than ordinary bell metal.

G. For rods and bolts. Very tough.

S. Bearing metal for all bearings of locomotive, marine and stationary engines, passenger, freight and street cars; roll neck bearings, thrust rings, slide valves, cross-head gibs, piston rings, etc. Very hard and durable, and not liable to heat nor cut the journal.

The elephant comes in as a trade-mark; and while there is every reason for believing that the metal is excellent, the beast needs improving. The public probably have no right to ask for any better metal than this company makes, but it would be perfectly justified in demanding a better elephant.

INDUSTRIAL RAILWAYS FOR MANUFACTURING ESTABLISHMENTS. C. W. Hunt Company, 45 Broadway, New York. 40 pp., 7 × 9¾ in. [Not standard size.]

The C. W. Hunt Company makes light railways, coal-handling machinery and conveyers for carrying coal and a great variety of other materials and products about manufacturing and other establishments. Mr. Hunt, the head of this establishment, has developed a very complete system of light, narrow-gauge railways and rolling stock for such purposes, and the amount of ingenuity that has been exercised thereon is indicated by the fact that the machinery and appliances manufactured by this company are covered by no less than 91 patents. For the purposes aimed at this company has developed a system of narrow-gauge roads, in which, as far as possible, everything is reduced to standard forms and dimensions. A peculiarity of this system is that the flanges of the wheels are placed on the outside of the rails instead of the inside, as on ordinary railroads. The axles of the cars are arranged so that they will assume radial positions to the curves. The outer rails of curves are made of a special form, so that in running over them the flanges of the outside wheels bear on the rail, and carry the weight of the car. The proportion of the curves and of the wheels and the adjustment of the axles are so arranged that the tread of the inner wheels and the flange of the outer one form parts of a curve whose vertex is at the centre of the curve. As the axles can assume radial positions, the wheels will roll around curves with practically the same ease as on a straight line. The flanges are placed on the outside of the rails for the reason that on reaching a curve the flange of the wheel on the inner rail impinges against the latter. The resistance thus encountered tends to push the axle into a radial position, whereas if the flanges are on the inside of the rails, the flanges on the wheels on the outer rail come in contact with it, and the resistance encountered would then tend to move the axle in the wrong direction. For this reason the arrangement of flanges on the outside of the rails offers less resistance, and for roads of this character is preferred.

The standard gauge adopted for these roads is 21½ in., measured to the outside of the rails; and standard curves of 12 ft. radius, which are made in sections, are furnished. The tracks are laid on steel ties. A great variety of cars for different purposes and other appliances with plans of works showing arrangements of tracks, etc., are also shown.

The illustrations are good, without being first class. A fuller description of the arrangement by which the car axles act radially is, however, needed; and one is disposed to ask why cuts are designated by numbers running up into thousands—one of them is No. *A* 1,377. It requires a waste of intellectual force to apprehend this designation, when in reality it would be simply fig. 9 in the book if the illustrations were numbered consecutively. Surely things are hard enough now to understand without adding artificial difficulties of this kind.

The book is well printed, the description clearly written, and is altogether satisfactory. An ingenious sub-advertisement was enclosed with the pamphlet, and consisted of a table of the H.P. of transmission ropes, and another and a very convenient "metric conversion table" arranged by Mr. Hunt, and printed on gummed paper "for convenient insertion in memorandum books." This is an example which might be advantageously followed by other publishers of trade catalogues. Give us your important facts in tabular or other convenient form, and they will be preserved. The tables sent by the Hunt Company we have inserted in our "Molesworth," where they will remain.

EXCESSIVE COST OF LOCOMOTIVE REPAIRS.

Editor AMERICAN ENGINEER AND RAILROAD JOURNAL:

From calculations made from a table of locomotive returns for September, 1894, printed on page 42 in your issue for January, 1895, I find, estimating the cost of an engine to be $10,000, the average proportional share of that engine cost, expended annually for its maintenance, to be 12.7 per cent.

The highest mileage cost for repairs, 8.21 cents, which is shown in that table, is by the Norfolk & Western; the least, 1.74, is by the Hannibal & St. Joseph. The annual per cent. of engine cost values of the same being, respectively, 25 98 and 5.18.

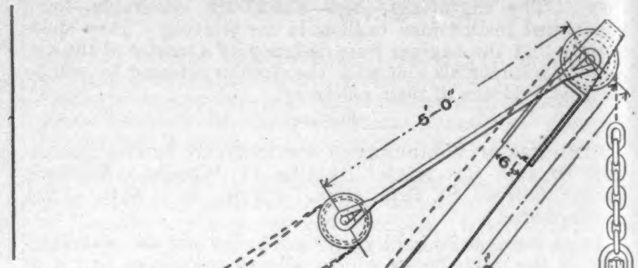
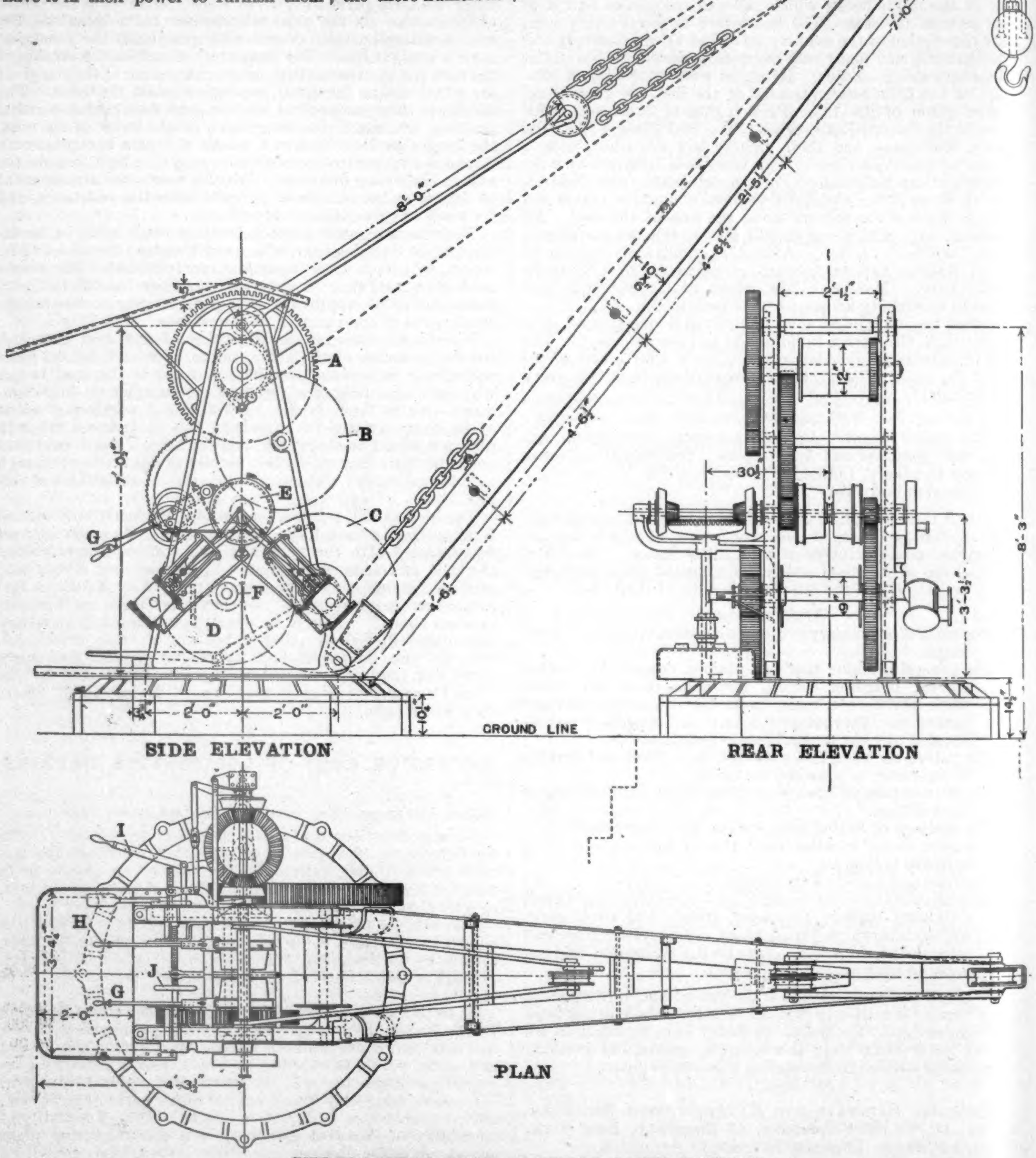
As to this same matter, I learn that for the entire Southern Pacific system the average yearly mileage per engine is 36,000, and that the engine mileage repairs for the same may be put at 6 cents, which, calculating as above, makes a showing required per engine per year for its maintenance of 21 per cent.

In considering this found annual repair percentage of cost, the question arises, Is it not excessive? Does a quantity of machinery of like cost employed as a manufacturing plant anywhere, or for any purpose where there are fair conditions supplied as to stability, involve yearly anything like such a proportion of its value? While, in the absence of positive figures in relation to it, from conclusions based on many years of practical use and observation of mechanical plants working under more clean and stable conditions than does that of a railroad's rolling plant, I am sure that the last far and, in comparison, ruinously exceeds the first. This being true, is it not to the general instability and the unevenness of the rail's plane, especially at its joints, as a path for engine and

car-wheels, the consequent variety and suddenness of motions which are thus engendered in the moving masses, the dust or mud, as the case may be, that is ejected from beneath the sleepers and forced into and among all the moving machinery—is it not to these and other like abnormalities that this excess should be charged ?

The question, then, is, How excessive is this annual rolling plant maintenance charge over that of fixed machinery operating, as such generally does, under the more favorable conditions ?

I seek reliable answers to this question from all who may have it in their power to furnish them ; the more numerous

FIVE-TON STEAM CRANE, BALTIMORE & OHIO RAILROAD.

the answers the better, for by such a more correct average may be determined. I therefore respectfully ask those who keep an account with their respective plants, other than those of a locomotive kind, to determine a fair cost value of the same, and from that, in connection with the annual repair or renewal charges entered against it, to compute the per cent. which is yearly required to maintain it in its original integrity. If those who can will do this, and at their earliest convenience, they will favor me much, and also contribute materially to the cause of applied mechanical science and to a needed fund of statistical knowledge as well.

Any conclusions that are the result of this inquiry will, when completed, be cheerfully mailed, on application, to those who may aid me in reaching them.

JOSEPH ANTHONY.

601 TEMPLE STREET, LOS ANGELES, CAL.

FIVE-TON STEAM CRANE, BALTIMORE & OHIO RAILROAD.

THE engraving on page 252 illustrates a steam crane that was built at the shops of the Baltimore & Ohio Railroad, and is at work in their freight depot at Mount Claire, Baltimore. The crane is driven by a pair of engines having cylinders 5 in. in diameter with a 6-in. stroke of piston, and making 150 revolutions per minute. As will be seen from the side elevation, the cylinders stand at an angle of 45° with the vertical and 90° with each other, and their connecting-rods take hold of the same crank-pin. The main shaft crosses the crane, and on it are the pinions for hoisting, raising the boom, and swinging. The gearing for hoisting consists of a pinion 6.27 in. in diameter, having 13 teeth of 1½ in. pitch. It is on the main shaft, and can be thrown in and out of gear by means of a clutch operated by the hand-wheel *J*, as shown on the plan. This pinion meshes in with the gear *D*, 34.38 in. in diameter, having 72 teeth, that is on the same shaft with a pinion, *F*, of 19 teeth and 2 in. pitch, meshing in with the gear *C*, having 60 teeth that is on the winding drum. Thus, when the engines are running at 150 revolutions per minute, the winding drum turns at the rate of about 8½ revolutions, giving an average hoisting speed of something more than 30 ft. A 1-in. chain 42 ft. long is used for hoisting, and carries the load direct. The load is held by a strap-brake acting upon a drum fastened to the pinion on the main shaft, and operated by the lever *G*.

The gear for hoisting the boom consists of a 6-in. pinion having 15 teeth of 1½ in. pitch, that is driven by a clutch on the main shaft operated by the lever *H*, shown on the plan. This pinion meshes in with a gear, *B*, having 83 teeth, that is on the same shaft as a pinion of 13 teeth and 1½ in. pitch, that meshes with the gear *A* on the winding drum. The chain used is made of ⅝-in. iron, is 46 ft. long, and is rove in four-fold for taking the strain. The boom can be held by a strap-brake operated by the handle *H*, but when out of service it is ordinarily held by a dog and ratchet-wheel, shown in dotted lines in the side elevation.

The crane can be swung in either direction by means of bevelled pinions on the main shaft that are shown in the rear elevation, and have 12 teeth meshing in with a horizontal gear of 48 teeth, that is keyed to a vertical shaft carrying the driving-pinion at its lower end. As one or the other of these pinions is used for driving the crane will swing to the right or left. The clutches for this work are connected by the system of levers shown in the plan and operated by the lever *I*.

The boom is made from two sticks of yellow pine 10 in. × 6 in., tapered toward the ends and bolted together with ⅝-in. bolts and separating pieces. The working parts are held by a substantial iron frame, the principal dimensions of which are given upon the engravings. Such a crane as this is of very cheap construction, and for handling freight of even moderate weights it has been found to be exceedingly convenient, and has effected a great saving in the work done about the depot.

YARD ARRANGEMENTS ALONG HEAVY-TRAFFIC HIGH SPEED RAILROADS.*

BY A. FLAMACHE.

(*Concluded from page 229.*)

CONCLUSIONS.

IF we make a careful examination of the ideas which precede, we will see that their spirit tends toward an ideal arrangement, the scheme for which is shown in fig. 52—an arrangement which is evidently possible in principle, and its complete application is merely a matter of expense.

We can express the same order of ideas in another way by saying:

"Any junction station whatever being given and being supposed to be treated by taking account as far as possible of the local exigencies of the case (even admitting the actual state of things to correspond better to these exigencies), then we may suppose that we lead off sidings from the two main tracks which are reserved for the sole use of trains in transit, giving us fig. 54, which can be rectified by rearranging the two tracks, as in fig. 55, when we thus obtain the type which it should be our constant effort to attain."

It is evident that a train in transit will only pass one point switch, and that at the beginning of the yard, and one trailing switch; there are also two cross-overs on the track next to the local tracks.

To this minimum it is well to add two other switches, one point and one trailing, which would necessitate the doubling of the track *B* in order to permit the side-tracking of trains running over this line, without compelling them to cross the main line *A*. The two cross-overs can also be avoided by the adoption of junctions with an underground passage, as shown in fig. 28.

We can at once see the great advantages that the method of arrangement which we have advocated possesses and which we can summarize as follows:

From the Standpoint of Operation.—It is the one most favorable to the handling of high-speed trains, and, at the same time, it leaves the service to the widest liberty of choice as to the local arrangements.

From the Motive Power Standpoint.—Causes for slackening speed being avoided, a given commercial speed can be far more readily attained. The number of signals which the driver is obliged to observe is reduced to as few as possible.

From the Standpoint of Switches, Signals, and Permanent Way.—The maintenance of the main tracks, and especially of the apparatus which is in use, is greatly facilitated, as well as the wear and tear of the working parts reduced. The frequent changes that the modifications in the local service may require in order to adapt it to circumstances that cannot be foreseen should be made exclusively on the secondary track—that is to say, so that they cannot be interrupted by the passage of high-speed trains.

The question of cost then remains. The application of this system to the stations taken as an example have convinced me that this combination, which is so favorable in its results, is, at the same time, the most economical. If it necessitates the acquisition of certain supplementary land in order that the main lines may be doubled, it shows a marked saving in the location of tracks and signal apparatus, a saving that will repeat itself in a few years on heavy traffic lines.

* Bulletin de la Commission Internationale du Congrès des Chemins de fer.

NOTES AND NEWS.

A Large Tire.—The Midvale Steel Company have recently rolled what are, we believe, the largest steel tires that have as yet been made. They are 108 in. outside diameter, and were rolled in their regular tire mill. The use to which they will be put will be that they are to be shrunk upon the rim of some heavy belt and fly-wheels intended for the high-speed engines of an electric-lighting plant.

Reserved Seats.—A measure for permitting passengers to retain the places they have chosen in the compartment of a railway carriage is under consideration by the French Minister of Public Works. The idea is to pin to the lining of the carriage a piece of colored cloth corresponding with another given to the passenger, and rendering any tampering with them liable to a fine of £4.

High Resistance Shunt around Circuit Breaker.—Mr. Thomas Coykendal, the Chief Engineer of the Cornell Steamboat Company, has introduced a novel method of indicating the continuance of the short circuiting of the line in the power house of the street railway at that place. It is the practice on some roads, when the circuit breaker flies out to replace it at once, and then, if it flies out again, to replace it once each minute until it remains in place, a practice, by the way, that may result in the wrecking of a portion of the machinery or the development of beautiful but expensive fireworks, as was shown in the case of the Cincinnati power house. Mr. Coykendal's device consists in a high resistance coil of German silver having a resistance of 7 ohms, that forms a shunt around the circuit breaker, and while the latter is in place it is non-operative, but when the breaker is out it will carry enough current to the line to light the cars nearly as well as when the circuit breaker is closed, or move a car away from a position where it is an obstruction or in danger, as upon a railroad crossing. The electrician, then, instead of throwing the circuit breaker back, merely watches the ampère meter, which rises to 75, until it drops back to 45, when the breaker will remain in position, and it can be put back without danger.

The Temperature of Feed Water Delivered by an Injector.—In response to an inquiry made to the Nathan Manufacturing Company with reference to the temperature of water fed into a boiler by an injector, they have supplied the following very interesting information. They say:

"We take pleasure in giving herewith the results of actual experiments just made on the lines suggested by you. The

temperature of the feed-water as delivered into the boiler by an injector or steam jet apparatus is influenced, apart from the steam pressure, by the quality of the steam (whether dry or wet), by the lift which the injector is called upon to overcome, by the initial temperature of the feed water, and by the capacity of the injector—that is to say, whether it be worked to its maximum capacity or not. With a lift varying from 4 to 5 ft., an initial temperature of the feed water of 75° F., and with steam and water valves of the injector open to their full, we have delivered water into the boiler at the following temperatures under varying steam pressures :

Pressure per square inch.	Temperature of delivered water.
140 lbs.	200° F.
150 "	210° "
160 "	222° "
170 "	230° "
180 "	236° "
190 "	244° "
200 "	250° "

"After these tests had been made we attempted to repeat them with a lift reduced to 2 ft., when our thermometer 'went back' on us by bursting, putting a sudden end to our experiments."

A Limit of Speed for Trolley Cars in Brooklyn.—In a recent discussion before the Board of Aldermen in Brooklyn, it was stated by one member that already 103 lives had been sacrificed under the trolley wheels in that city, and 407 persons had been maimed.

Lawyer Raphael J. Moses has submitted a volume of alleged reliable and startling information to Mayor Schieren about the actual speed of the trolley cars. He furnished a series of tabulated statements which show that in one instance as high a speed as 30 miles an hour was reached, and in very many instances 20 miles.

He says that each case is attested by the affidavits of two railroad men, who actually rode in the cars and noted the time of starting and arriving. Some of the affidavits treat of the speed in passing school buildings. This shows, according to Lawyer Moses, "the shameful rate of 17 to 20 miles an hour." Mayor Schieren has forwarded copies of the affidavits to all the railroad Presidents.

An ordinance was finally adopted which provides that the speed of the trolley cars shall not exceed 6 miles an hour within a radius of ½ mile from the City Hall and ferries, 8 miles an hour within a mile of these points, and 10 miles an hour in the other sections of the city. The cars must also come to a full stop at steam railroad crossings, and shall not run faster than 4 miles an hour before crossing surface roads and before crossing Schermerhorn Street and Clinton Street.

The platform gates on the track side are to be kept closed, the cars must be licensed, and not more than three persons are permitted to ride on the front platform. The police are to be required to enforce the trolley ordinances, and each violation calls for the imposition of a $25 fine.

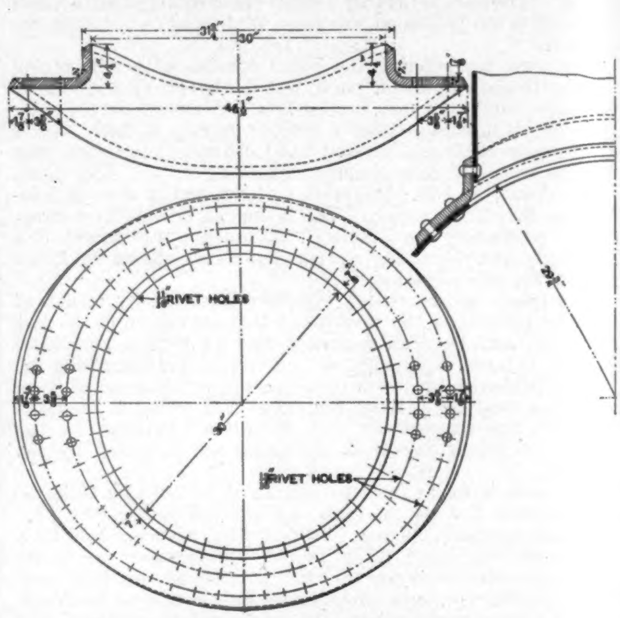
Dangers of Defective Eyesight.—A deputation from the British Ophthalmological Society recently waited upon Mr. Bryce, President of the Board of Trade, to urge the adoption of more precise tests for eyesight in the examination of the mercantile marine and railway servants.

A new system of tests, based on the report of the Committee of the Royal Society on Colour Vision (Parliamentary paper C—6,688, 1892) was brought into operation on September 1 last; it covers a period of 15 months—*i.e.*, from the date of the previous report to the date of the introduction of the new system. The new examination consists of three parts —(*a*) the form vision test, which is intended to ascertain whether a candidate has good or bad sight; (*b*) the color vision test, whether he can distinguish colors correctly ; and (*c*) the color ignorance test, whether he can name colors correctly. For form vision the candidate is examined by Snellen's letter test, or, if he cannot read, by the "dot" test. In the former case the candidate is required to read letters of different sizes arranged in rows on a sheet placed at a distance of 16 ft. from him. In the latter case the candidate is required to answer questions with regard to the number and position of dots arranged in different lines and groups on a sheet placed at a distance of 8 ft. The color vision test is conducted by means of Holmgren's wools. The candidate is required to select from a general heap of wools of different colors those skeins which in his opinion match with one or the other of three test skeins of the colors of (1) light green ; (2) pink or light purple ; and (3) red. The object of the color ignorance test is to ascertain whether the candidate knows the proper names of colors, so as to insure his being able to name correctly the red, green, and white lights. This test is introduced mainly to meet the case of foreign seamen serving in British ships. Full details of the new method are given in the Parliamentary paper already referred to.

The ophthalmologists admitted that the instructions for examination of the mercantile marine service issued by the Board of Trade proceeded upon true lines, except as regarded refraction.

A correspondent in *The Times* suggests that if the ophthalmologists could suggest some examination which would insure that look-out men should keep their eyes open during the night, especially in short-handed vessels, it might be more practical ; but certainly ships of war do not require this precaution.

Pressed-Steel Dome Base—Pennsylvania Railroad.—The hydraulic press having demonstrated its capability of forming intricate and varied shapes from sheet and plate metal, is receiving a more and more extended application for this class of work, and in addition to the several manufactories that are turning out stamped metal specialties, some railroad companies have found it economical to own their own presses and dies and form the parts for themselves. This can, of course, only be done where large numbers are wanted in duplicate. The Pennsylvania Railroad are now pressing a great deal of boiler work that was formerly done at the flanging forge. One of the



PRESSED-STEEL DOME BASE.

simplest pieces formed is the front flue sheet for locomotive boilers. The sheet is heated to an even temperature in a furnace and put into a heavy press made by the Morgan Engineering Company. A single stroke of the ram completes the operation, and the sheet is ready for drilling. Three men are employed on the work, and they can turn out a flue sheet flanged and straightened at the rate of one in about five minutes. Another part formed on this same press is the dome base, of which we publish an engraving. As all of the dimensions of the finished base are given, it is unnecessary to recapitulate them here. The original sheet is circular, 46½ in. in diameter and ⅞ in. thick. It is flanged and curved to fit the boiler shell by one stroke of the ram. It is riveted to the shell of the boiler by two rows of ⅞-in. rivets, there being 46 in the inner row and 54 in the outer. It is held to the dome by 45 ⅞-in. rivets. The drawings from which our illustration is taken is of the base used on the Class P locomotives, the cylinders for which were illustrated in our last issue.

Severe Test of Armor Plate.—The 13-in. gun was fired at an 18-in. Carnegie plate at Indian Head on May 17, to secure a comparison of the damage created by its 1,100-lb. projectile and the 850-lb. shell of the 12-in. rifle, the object being to demonstrate that the new battleships should be armed with the larger guns. On May 1 a Holtzer shell from the 12-in gun in an acceptance test of the 18-in. side armor of the *Oregon* had been fired at the same plate that was used on the 17th, with a muzzle velocity of 1,926 ft. per second, and a striking energy of 21,885 foot-tons, and had cracked the plate from top to bottom, but had destroyed only one of its 26 armor bolts, the pro-

jectile penetrating 10 in. and then going to pieces, its point welding into the plate.

This shot had been fired with a velocity corresponding to the maximum striking velocity procurable from the 12-in. gun at 1,300 yds. range, which is estimated to be about the distance which would probably be chosen by battleships in action. The same conditions of velocity at the 1,300 yds. distance were observed with the 13-in. gun, the initial velocity to its 1,100-lb. Wheeler-Sterling solid steel shot being 1,942 ft. per second, or 18 ft. greater than in the case of the 12-in. gun, but the striking energy reached the enormous figure of 28,800 foot-tons.

The shot struck in the right half of the plate, breaking it in four pieces, and buried itself in the sandbank behind the plate, where, upon recovery, it was found to be broken to pieces, the head whole but somewhat fused at the point. The heavy oak backing behind the plate was completely demolished by the terrible energy of the blow. This clearly demonstrated the superiority of the 13-in. gun over the 12-in. weapon for the same range, and the ordnance officers present claimed it showed no armor in existence could keep out the 13-in. projectile at 1,300 yds. This, however, concededly depends on the projectile, as the next shot evidenced.

A Wheeler-Sterling semi-armor-piercing shell similar to the preceding one, but hollowed out to contain a 53-lb. charge of explosive, was aimed near the base of the armor where the plate tapered to 15.6 in. in thickness, the same velocity being used. The plate met with similar disaster, breaking and letting the shell through after it had penetrated 7 in. The shell broke up; all its fragments went through, and were found in the sand behind.

The experts, however, are not prepared to accept these performances as conclusive proof that 13-in. shells have yet been found to demolish 18-in. plates, or even plates of less thickness. The armor attacked had already stood the strain of two acceptance shots from the 12-in. rifle and one from the 13-in. gun, and two of these shots had split the plate through and through. As the dimensions of the plate were 16½ ft. long, 7½ ft. wide, 4 ft. of which was 18 in. thick, then tapering to 8 in. at the edge, there was no such exhibition of tenacity as would be looked for in a whole plate. The tremendous energy of a shot from the 13-in. "Peacemaker" is not doubted, but it is claimed that the comparatively insignificant penetration of the shells before the overstrained plate gave way and let them through is significant. Nevertheless, no doubt remains that the 13-in. guns of the *Massachusetts*, *Indiana* and *Oregon* could speedily destroy any warship afloat in the world to-day, and that the great battleships of the *Majestic* and *Magnificent* class now building in England, with their belts of 9-in. Harveyized armor, would not last any time if American gunners are skilful.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

XV.—METHOD OF DETERMINING TAR AND TAR ACIDS IN WOOD PRESERVATIVE.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page 202.*)

OPERATION.

Pour into a 100 cubic centimetre graduate 80 cubic centimetres of 88° B. gasoline, and add the material to be tested up to the 100 cubic centimetre mark. Put in the stopper and shake thoroughly. Allow to settle until the tar settles to the bottom, or, as happens in many cases, part of it settles and part adheres to the sides of the graduate. If the tar settles off nicely, none of it adhering to the sides of the graduate, read off the number of cubic centimetres occupied by the tar, and calculate the amount as described below. If any of the tar adheres to the sides of the graduate, add a few cubic centimetres of gasoline to a second graduate of the same size, drain it, and then quickly but carefully pour the gasoline solution from the first graduate into the second, taking care that none of the tar goes along with the gasoline. Stopper the second graduate quickly, and read off the amount of gasoline solution in it. The difference between this reading and 100 cubic centimetres, when corrected for the error introduced by the volatility of the gasoline, and the difficulty of pouring it all out, shows the volume occupied by the tar in the first graduate, from which the percentage can be calculated, as described below.

To determine the tar acids, pour 80 cubic centimetres of the gasoline solution, above referred to, into a clean 100 cubic centimetre graduate, provided the tar has been determined without transfer. If the transfer has been made, pour or suck out with a pipette the gasoline solution in the second graduate, until 80 cubic centimetres are left. Then add 20 c.c. of caustic soda solution, and 4 cubic centimetres of ordinary alcohol. Shake thoroughly, and allow to stand until the material separates into two layers. The tar acids and part of the alcohol go into the lower layer. Read off the volume of this lower layer and calculate the amount of tar acids, as described below.

APPARATUS AND REAGENTS.

The apparatus required by this method is a 2 cubic centimetre pipette to measure the alcohol, and several 100 cubic centimetre graduates provided with glass stoppers and feet, so that they will stand. The flat form is much better than the round form, since the solution of wood preservative in gasoline is moderately dark, and the readings can be much better made if the mass of liquid is in a layer thin enough, so that light is readily transmitted through it.

Gasoline of the gravity specified is readily obtained in the market.

The alcohol is the 95 per cent. grade.

The caustic soda solution is made by dissolving a pound of commercial stick caustic soda in a quart of water, and diluting with water until it shows a gravity of 13° B. Of course the gravity measurement should be made after the liquid has cooled to the temperature of the air.

CALCULATIONS.

I. *Tar when it Does not Adhere to the Graduate.*—Since 20 cubic centimetres of the wood preservative are taken to start with, if the volume of the tar obtained by reading the graduate is 1.5 cubic centimetre, for example, it is evident the amount of tar is ($1.5 \times 100 \div 20 =$) 7.5 per cent.

II. *Tar when it Adheres to the Graduate.*—If the gasoline solution could be poured off completely from the tar into the second graduate, and if none of it volatilized, it is evident that the calculations could readily be made from the readings described. But experiments indicate that there is a little vaporization of the gasoline and a little difficulty of pouring off completely. Accordingly, an allowance of 1 cubic centimetre is made for these errors. Suppose now, after the transfer, the reading of the second graduate is 97 cubic centimetres. This from 100 leaves 3 cubic centimetres for the tar; but the error of the transfer is 1 cubic centimetre. Hence, the actual volume occupied by the tar in the first graduate is 2 cubic centimetres, and the amount is ($2 \times 100 \div 20$) 10 per cent.

III. *Tar Acids.*—Let us suppose that the reading of the graduate, after treatment with the soda and alcohol, as described, is 32 cubic centimetres. Twenty of these we added with the soda. Furthermore, experiment shows that 3 of the 4 cubic centimetres of the alcohol added go into the lower layer with the tar acids and soda solution. Therefore the increase in volume due to tar acids is ($32 - 23$) 9 cubic centimetres. Suppose, now, the volume of the tar found, as above described, is 2 cubic centimetres. Also, it is allowed that 1 c.c. of the gasoline solution is lost during the transfer from the first graduate to the second, whether this transfer is made after the tar determination, or as a part of this determination, as described. There would be, therefore, 97 cubic centimetres of gasoline solution, which contains all the tar acids. But in the case supposed we find that 80 cubic centimetres of this solution contain 9 cubic centimetres of tar acids. Therefore 97 cubic centimetres, or the whole of the gasoline solution, contains ($80 : 97 :: 9 : 10.91$) 10.91 cubic centimetres of tar acids, or this amount differently expressed is ($10.91 \times 100 \div 20$) 54.55 per cent. This explanation may be briefly summarized as follows: Subtract 23 from the reading obtained when determining tar acids, and call this remainder a. Deduct from 100 cubic centimetres the number of cubic centimetres showing the tar and one more. Call this remainder b. Then make a proportion $80 : b :: a : x$. x shows the volume in cubic centimetres of the tar acids, and from this calculate the percentage.

COAL STORAGE PLANT AT PORT RICHMOND, PHILADELPHIA, PA., FOR THE PHILADELPHIA & READING RAILROAD, ERECTED BY THE DODGE COAL STORAGE CO.

NOTES AND PRECAUTIONS.

The material to which this method applies is a distillate of Georgia pine, known under various trade names, such as fernoline, spirittine, pine oil, etc. It is, of course, not applicable to all wood preservatives, and those made from other kinds of wood and from coal tar do not behave, when treated as the method describes, like the Georgia pine distillate.

If the 20 cubic centimetres of the distillate are poured into the graduate and then the gasoline added, it is much more difficult to get the gasoline and distillate thoroughly mixed than if the manipulation described is followed.

It will be observed that what is counted as tar is the material which separates from the distillate when treated with gasoline under the conditions described. No special effort has been made to determine what this is chemically, nor is it known whether the separation of the tar is complete or not. Also, there is some evidence that some of the gasoline remains dissolved in the tar, and increases its volume somewhat. No method is at present known of avoiding this difficulty, and accordingly the determination of the tar may be said to be in a sense arbitrary. But as long as the conditions and limitations of the method are known and understood, it is felt that no injustice is done by its possible and necessary errors.

There is quite a difference in distillates. Sometimes the tar will settle off nicely into a clean layer at the bottom of the graduate, whose volume can be easily read off. More often, however, the tar separates in flocculent sticky particles or clots which adhere quite firmly to the glass. The cause of this difference in behavior is not known.

The object of adding a few cubic centimetres of gasoline to the second graduate and draining, before the transfer, is to compensate in the tar determination for the volume of the gasoline solution that adheres to the sides of the first graduate. While this source of error may not be serious compared with some necessary errors in the method, it is thought best to avoid known sources of error as much as possible.

It is perhaps hardly essential to mention that when the transfer is made to measure the tar, the two graduates used must be alike in measurement.

It will be observed that there is an error in the tar acid determination when the transfer is made as a part of the tar determination, due to the fact that some of the gasoline solution holding tar acids remains sticking to the sides of the first graduate. There is no means at present known of avoiding this error. It is believed, however, that this error does not amount to more than 1 per cent., and perhaps less.

The use of alcohol in the tar acid determination is due to the fact that without the alcohol the line between the two layers is not sharp. Apparently some of the soap formed by the combination of the tar acids with the soda does not dissolve in the soda solution in absence of alcohol. In its presence the difficulty wholly disappears.

Direct experiment, made by adding to a 100 cubic centimetre graduate 20 cubic centimetres of the soda solution, 80 of the gasoline, and 4 of alcohol, shows that 1 cubic centimetre of the alcohol goes into the gasoline and 3 into the soda solution. It will be observed that it is assumed that the same thing takes place when the distillate is present.

The amount of gasoline vaporized during the transfer is, of course, affected somewhat by the temperature at which the transfer is made. Also, the manipulation has an influence. It is believed that the 1 cubic centimetre allowance should cover the necessary errors introduced by the volatility of the gasoline and the difficulties of the transfer.

The reason why so volatile a substance as gasoline is used to separate the tar is because no non-volatile material is known which separates the tar as satisfactorily as gasoline. Experiments with heavier non-volatile petroleum products have been made with unsatisfactory results. It is quite probable that further study will develop a more satisfactory solvent. It is, of course, well known that gasoline is not the only solvent that will separate tar from this distillate. It is, however, cheap and efficient, and may therefore reasonably be used until something better is suggested.

What is classed as tar acids, it will be observed, is what goes into the caustic soda solution. What these acids are, whether the separation of them from the neutral oils is complete, and whether anything else than tar acids and alcohol go into the soda solution, is not definitely known. In a sense, therefore, the determination of the tar acids is arbitrary.

Notwithstanding all the precautions that can be taken, it will be observed that the necessary errors of the method may be quite considerable. It is not expected that very sharp results can be obtained, but the limitations of the specifications under which the material is bought are so broad that very little difficulty has arisen, and the method has proved an excellent means of keeping moderate control over an important commercial product whose chemistry is very little known.

COAL STORAGE PLANT AT PORT RICHMOND, PHILADELPHIA.

The Dodge Coal Storage Company, of Nicetown, Pa., are just finishing a very extensive and complete coal storage plant, having a capacity of 180,000 tons, for the Philadelphia & Reading Railroad. It is being erected at Port Richmond, just north of the present storage yards of the railroad company.

The Dodge system of handling, storing and reloading the coal is simple and unique. From the time the car is run over the hopper into which it is unloaded until the coal is reloaded in the cars for shipment there is no shovelling, and no handling is required other than the raking up of a thin layer of coal that is left upon the ground when it is desired to use the floor for coal of a different size. The handling is done by means of scraping conveyers using the well-known Dodge chains, and though the height of the centre of the pile may be, as in the case under consideration, more than 70 ft., the coal need never be allowed to fall more than from 12 in. to 15 in., so that there is practically no breakage whatever.

Ordinarily the coal is stored in conical piles, but there have been cases where a very much greater storage capacity was desired than the ground room available would permit were conical piles alone to be used, and where an ingeniously braced enclosure was introduced that practically placed a cylinder of coal of the height of the enclosure and of the diameter of the pile beneath the conical portion. Such a system was used at the West Superior plant erected for the Lehigh Valley Railroad.

The general appearance of the plant is well shown by the half-tone reproduction of a photograph taken after the trimmers had been put in place, and while the buildings and other iron work was still in course of erection. The photograph was taken from the southeastern extremity of the plant, looking toward the opposite diagonal corner. The plot of ground that has been set aside for this purpose lies between Ann Street on the south, Byron Street on the north, the Philadelphia & Reading tracks on the east, thus closing Bath Street and the rear end of the lots fronting on Melvale Street to the west. The total dimensions within the enclosure are: Length, 1594.4 ft., and breadth 335 ft. from the centre of the unloading track. The arrangement of switches, main tracks and sidings for the yard is clearly shown by our engraving (fig. 1). From this and the photograph it will be seen that provision is made for the formation of six piles; the two at the ends will have a capacity of 20,000 tons each; the intermediate piles a capacity of 40,000 tons each, and the centre piles a capacity of 30,000 tons each. It is usually customary to place one reloader for each two piles; but in this case, in order to expedite the reloading for shipment, four reloaders are used, and these are so disposed that each of the 40,000-ton piles can be attacked from opposite sides at the same time. It is expected that the capacity of these reloaders will be 3 tons each per minute. When the plant is started, or when the reloaders are not at work, they stand out at right angles from the towers which they supply, so that they may not be buried under the coal, and it is in this position that they are shown in fig. 1, being marked *W*, *X*, *Y* and *Z*. The heavy outside circles that are concentric with the centre of the trimmers indicate the outside limits of the bottoms of the several piles; the circles in fine lines concentric with the heel or pivot of the reloaders are the rails upon which they (the reloaders) run, and the straight lines leading from the centres of the trimmers are the guy lines holding them in a vertical position. The location of the boiler-house, engine-house, hoppers and towers are also clearly shown. The steam plant consists of two 150-H.P. boilers placed in a house located on the transverse centre line of the plant, and from which the steam is piped to the several engines. The furnaces are designed for burning screenings and dust on the McClave grates with steam blowers that have been so successfully used in the anthracite mining regions for burning culm. In each of the four engine-houses there is a 100-H.P. engine for driving the machinery.

In fig. 2 we have an outline of the trimmers. The trusses are so designed that a certain number of bents at each end are standard, so that they are available for use with any span of trimmer that is likely to be erected, the intermediate bents being put in as the occasion may demand. It will be noticed that the angle made by the trimmer girders with the horizontal is about 27°. The contractors have found, as the result of their experience, that this is nearer the angle at which loose

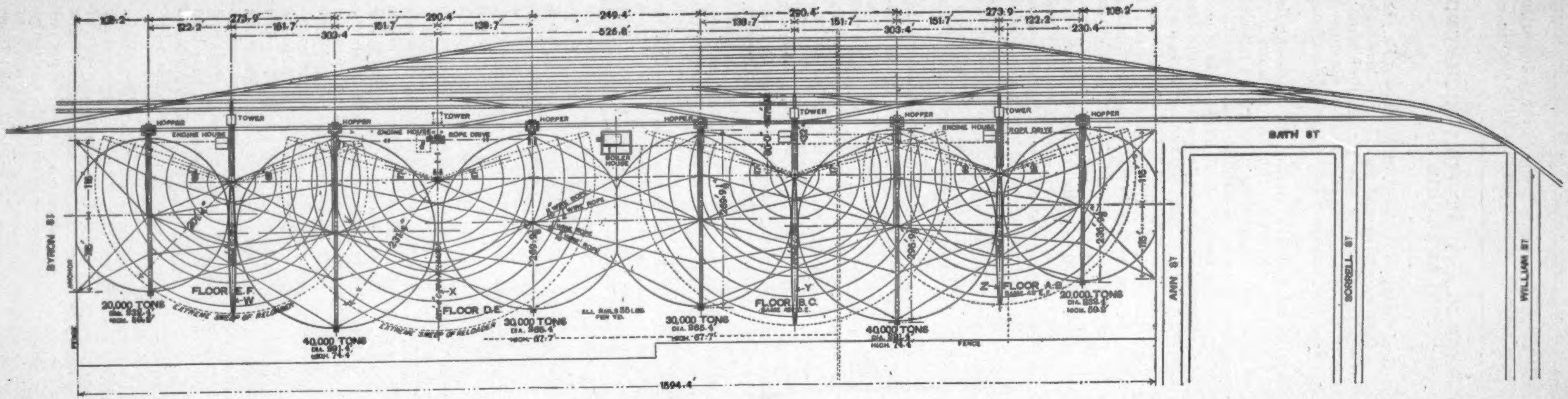


Fig. 1.

GROUND PLAN OF COAL STORAGE PLANT OF PHILADELPHIA & READING RAILROAD AT PORT RICHMOND.

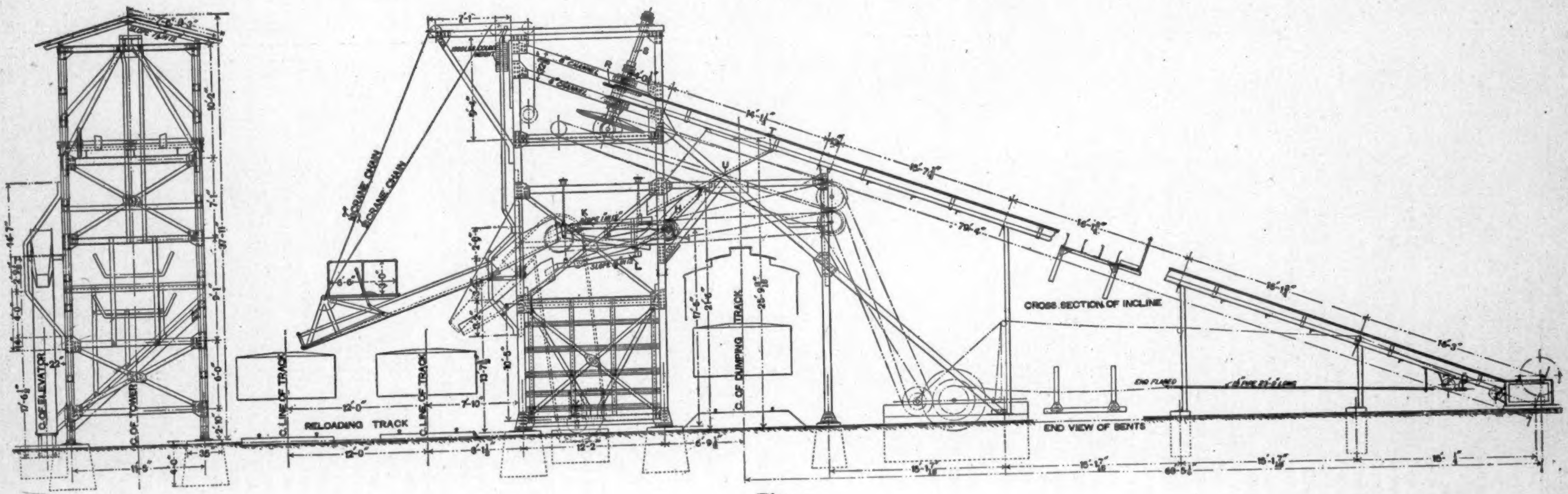


Fig. 4.

SIDE ELEVATION OF RELOADING TOWER OF COAL STORAGE PLANT AT PORT RICHMOND.

coal will stand than 30°, as is usually given in text and pocket-books for the angle at which coal begins to move.

The system of storing the coal is very simple. Beneath the entering track, and directly in a line with the centre line of the trimmer as shown in fig. 1, there is a hopper into which the cars are dumped, and which has a capacity sufficient to take the whole load of the car. A chute in the bottom of the hopper, controlled by a sliding door, delivers the coal by gravity into the foot of the inclined trough that leads to the top of the trimmer. In this trough the scraping conveyer works, its course being indicated in fig. 2. Starting with its load at the bottom of the hopper between the rails, it moves up through the trough to the apex of the trimmer, returns along the line indicated above the bents, passes over the idle pulleys *M* and *N* (fig. 2), and thence to the foot of the incline. The driving pulley of the conveyer is at the top of the trimmer, and it is in turn driven by a rope leading off from pulleys in the nearest engine-house. Thus the pull is at the delivery end of the loaded chain.

We have said that the system is so designed that the coal need never be allowed to fall more than from 12 in. to 15 in. in the plant. This would, of course, be impossible were it carried to the apex of the trimmer before it were allowed to fall to the floor below. To obviate this difficulty and secure the desired end, that portion of the conveyer trough which is on the trimmer proper is left open at the bottom from a point near that indicated as *P*. Thus, when commencing operations with an empty floor, the coal drops out at this point and starts the pile. Beneath the tower *Q* carrying the rope-drive, and below the bottom line of the trough, there is a reel upon which a steel ribbon $\frac{3}{32}$ in. thick and 12 in. wide is rolled. The end of this ribbon can be drawn out and up by means of a windlass and a wire rope to the apex of the trimmer. Therefore when the pile has reached to within about a foot of the discharge opening, this ribbon is run out, and, forming an extension to the bottom of the conveyer trough, it carries the point of discharge out and up, the process being repeated until the pile is completed and the floor full. These conveyers are to run at a speed of 200 ft. per minute, and will have a capacity of 3 tons per minute.

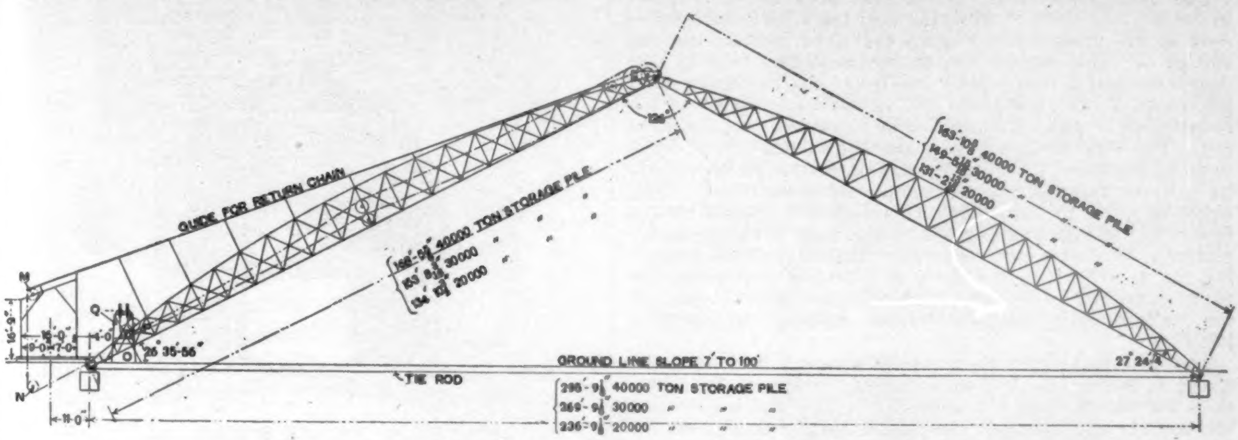


Fig. 2.

OUTLINE OF TRIMMERS OF THE PORT RICHMOND COAL STORAGE PLANT.

Fig. 3 shows in some detail the plan of the pivot end of the reloader. This portion of the apparatus consists of an arm varying in length according to the size of the pile to be attacked, as given in the dimensions marked on fig. 1; the arm is pivoted at one end and rests upon small flangeless wheels running upon the circular rails, weighing in this case 35 lbs. to the yard. The reloading arm is swung by means of anchor lines that run along the outside of one of the rails near the outer extremity, and which are firmly anchored to the ground just outside the extreme throw, which ranges through an arc of 204°. These anchor lines pass over pulleys properly located, and then pass through a length of gas pipe to a point near the centre, where the arrangement of sheaves is like that shown in fig. 3. The pipe is used to do away with sag and slack, and the sheaves are so adjusted as to keep the length of the hauling lines as nearly constant as possible. The pipe connections are shown at the left of the engraving, while to the right the lines lead off to the winding drums. The conveyer is an open-side scraper conveyer operated with a Dodge chain and cutting into the side and foot of the coal pile. The operator stands on the pivot platform, and by means of hand-wheels controls the motion of the conveyer and the swinging of the reloader. The operation is apparently simple: the hauling line is drawn in until the conveyer bottom cuts into the pile and the scrapers bring the coal up to the centre, and then as the supply falls off the reloader is swung in more and more until the whole pile is removed. The skill in handling comes in the prevention of a downfall and consequent burying of the reloader. While the natural quiescent inclination of a coal pile is about 27°, when that same coal has been subjected to a compression of a superincumbent weight, and the pile is eaten into from

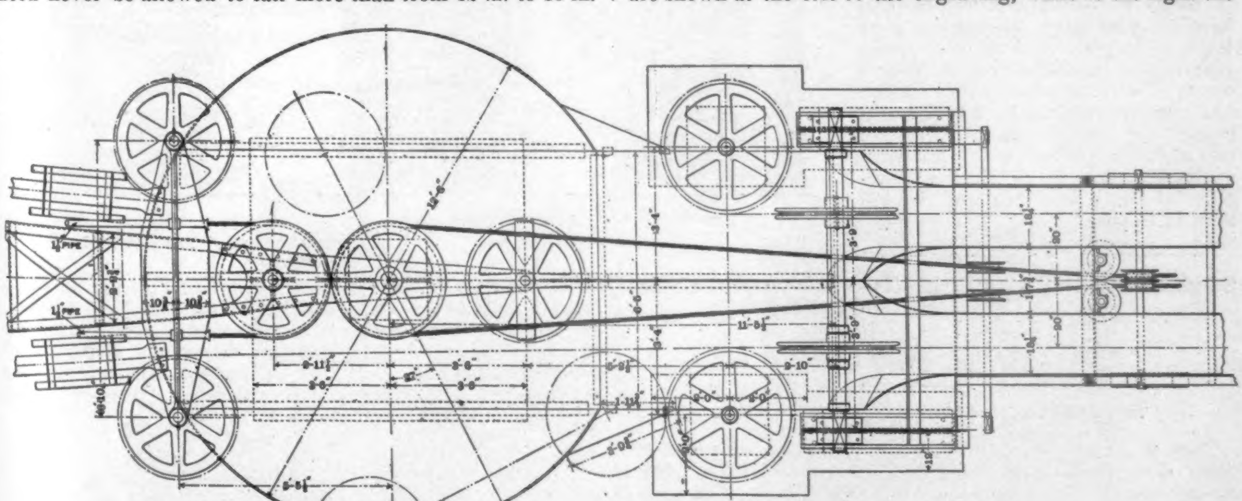


Fig. 3.

PLAN OF PIVOT OF RELOADER OF COAL STORAGE PLANT AT PORT RICHMOND.

the bottom, that same coal may stand at a very much steeper angle, and this may result in an avalanche when the foundation has been sufficiently cut away. The skill of the operator is made manifest by the alertness of eye by which he detects the first symptoms of a coming fall, and backs the reloader out of the way.

When the coal leaves the reloading arm it is carried up the incline shown coming down to the right in fig. 4. The conveyer chain passes around the sprocket wheel *R* that is keyed to the inclined shaft *S*, while the coal has already been delivered at the point *T* lower down the slope into the inclined trough *U*. This trough has an inclination of 6 in 12 that causes the coal to flow rapidly and freely into the upper shaking screen *K*, which is given 131 vibrations a minute by the eccentric *H*, to which it is attached by means of a long eccentric-rod. The coal escaping from the end of this screen drops upon an incline of 1 in 12 and thence into an adjustable chute for delivery into the cars on the outer shipping track. This chute is slung by suspending chains from a bracket on the tower, and is raised or lowered by the man in charge on the platform, where his lever is shown. Reference to the engraving (fig. 4) will show that there is a gate at the foot of the chute controlled by the lever, so that the flow of coal to the car can be temporarily stopped without stopping the conveyer itself.

The coal that drops through the screen *K* falls upon the screen *L*, which also has an oscillating motion of 131 vibrations per minute from the eccentric *I*. The coal is delivered into a chute and falls into cars on the loading track next the towers, and which is marked *G* in fig. 1. Each tower, therefore, screens and delivers two sizes of coal to the cars. The dust falls into a bin occupying the whole base of the tower, and from which it is taken through a suitable opening. This will be the fuel used under the boilers of the plant, and the excess will be removed by hand to cars and hauled away.

The whole of the structural work of the plant is of steel, and the work has been most thoroughly done. The engines are coupled direct to the main line of shafting, and this is cut up and subdivided by friction and tooth clutches, so that each and every moving part can be handled independently of all of the others. The system has been in use for a number of years, and is being widely introduced by coal handlers who find it necessary to store large tonnages. Among other large plants that have been erected, there is one at West Superior, to which allusion has already been made, which has a capacity of 100,000 tons in two piles; one at South Amboy, with a capacity of 190,000 tons, in 16 piles; and another at South Plainfield, of 310,000 tons, in 14 piles.

SOME FACTS RELATING TO CERTAIN TYPES OF WATER-TUBE BOILERS.*

(*Concluded from page* 219.)

THE AGGREGATION OF PIPE AND FITTINGS.

THIS stage of boiler-making occupies the same plane in boiler development that the rotary engine does in its field. Almost everybody has been touched by the disease. The materials are all at hand, and the details can be mostly bought ready made. By the addition of another elbow, coupling or return bend, the budding genius of a boiler inventor sees the heights of fame and dollars within his reach.

As a rule it can be said that the later the date of the attempt the worse the results.

They are all based on the following recipe:

First, crowd in the greatest possible amount of heating surface, no matter how or at what sacrifice of other equally necessary requirements.

Second, the more bends and right angles so placed as to obstruct circulation the better.

Third, on the same basis that a steam-engine will run more regularly without than with a fly-wheel, cut down the steam and water capacity to the lowest possible limit.

Fourth, make it as far as possible out of pipes and fittings screwed together, and place the fittings and joints in the hottest position.

Fifth, firmly take the position that it will never need repairs, and render them difficult to make.

Sixth, assert that it will never need internal cleaning, and avoid all facilities for so doing.

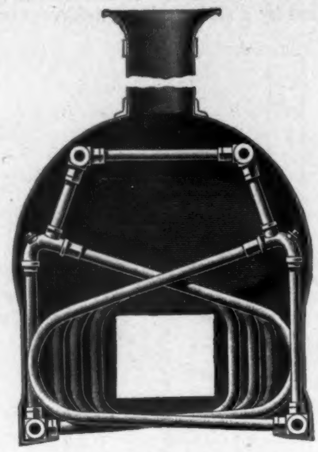


FIG. 48.—DANCE'S BOILER, 1833.

"*Engineer*," *August* 17, 1894.

Seventh, no matter how closely it copies some other discredited aggregation, give it a new name, and it will go for a while.

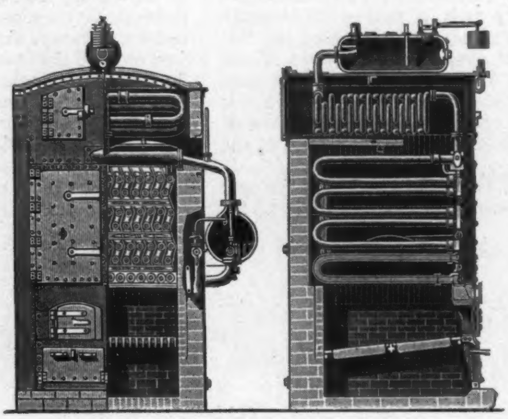


FIG. 49.—BELLVILLE'S BOILER, 1865.

Trade Circular.

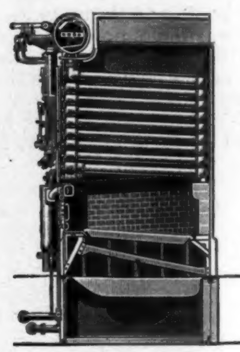


FIG. 50.—1877.

Trade Circular.

Sir Charles W. Dance, the inventor of a steam road-carriage in England, joined Joshua Field (of Maudsley & Field, the builders) in patenting the first boiler of this description (fig. 48), and can be considered the father and godfather of troubles in this line. The lower tubes were used as grates, as in Gurney's 1826 design. The familiar "up-flow" and "down-flow" pipes, connected by fittings (made specially, as there were at that time no regular ones on the market), were present. All ideas of the necessity of steam or water capacity

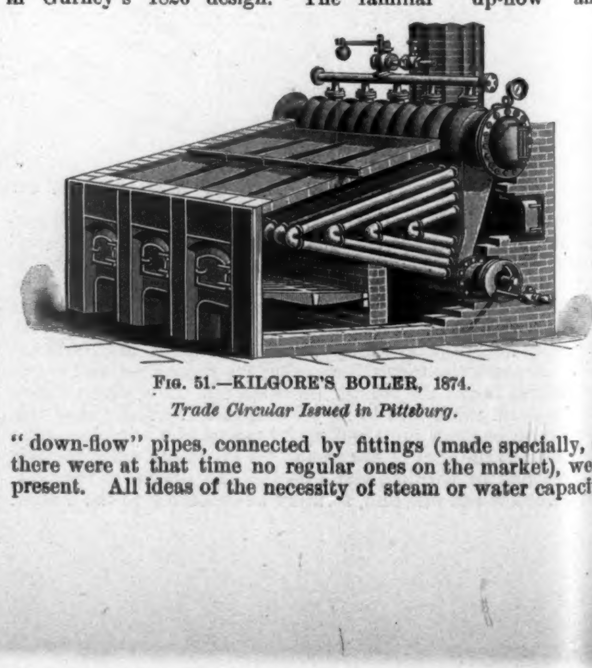


FIG. 51.—KILGORE'S BOILER, 1874.

Trade Circular Issued in Pittsburg.

* From advance sheets of a publication by the Babcock & Wilcox Co.

or desirability of access for internal cleaning were absent. Surface, weight and space occupied dominated the design.

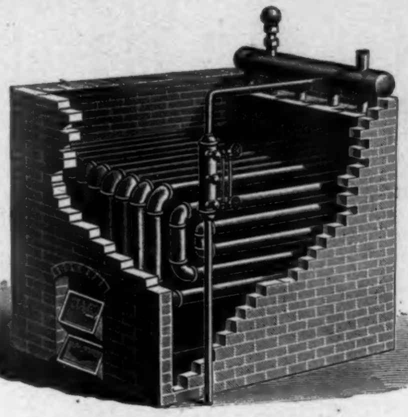


Fig. 52.—SHACKLETON'S BOILER, 1876.
Trade Circular Issued in Seneca, N. Y.

Belleville, a French engineer, introduced a box-coil boiler (fig. 49), made up of bent U pipes screwed into return bends,

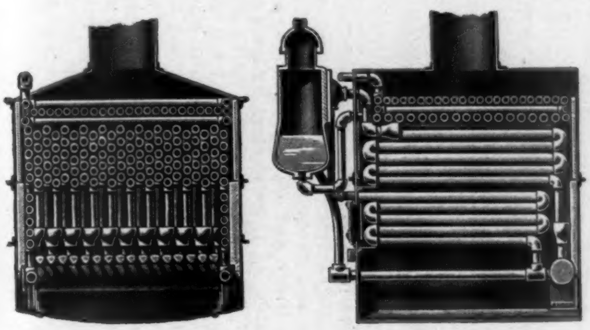


Fig. 53.—HERRESHOFF'S BOILER, 1890.
International Engineering Congress, 1894.

a series of these coils being placed vertically side by side, connected at the top to a separating drum and at the bottom to a common feed-pipe. It was fitted with various automatic

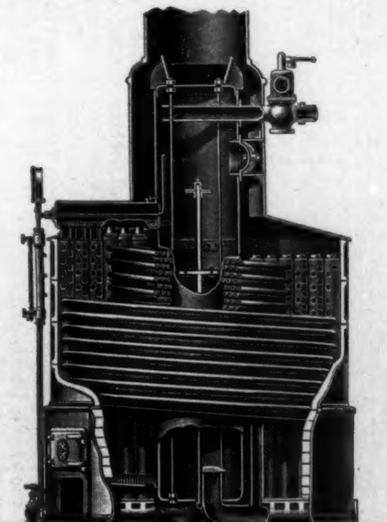


Fig. 54.—WARD'S BOILER, 1879.
U. S. Naval Reports.

devices for controlling the feed, circulation, blow-off, and pressure—the latter as it was found necessary to run the boiler at a higher pressure than that desired in the engine, throttling down to prevent the water from bodily leaving the boiler. They are used principally in marine service.

About 1877 the bent pipe was discarded and return bends used on both ends of a series of straight tubes. This boiler (fig. 50) could be cleaned by taking it all apart. One particular advantage of this boiler seems to be that the steamship owner has the opportunity to constantly displace paying freight by carrying round a mass of brick-work.

J. C. Kilgore originated the "Eclipse" boiler (fig. 51), using pipes and fittings to build up his U tube sections; otherwise it was a copy of Allen's 1872 design.

Joseph Shackleton (fig. 52) used return bend units connected to vertical manifolds, placed side by side, connected at the top to a steam collector and at their bottom ends to a common feed-pipe.

Herreshoff (fig. 53) rechristened Belleville's 1877 boiler, staggered the tubes, and added a feed-water coil above it made up in the same manner, made of pipes and fittings.

Charles Ward used a vertical cylinder surrounded by a series of concentric coils (fig. 54) interrupted twice in their circumference, on opposite sides, by vertical manifolds. These manifolds on one side were connected by a radial pipe to the bottom of the cylinder, and at the other side to a similar pipe connecting near the top of the cylinder.

E. E. Roberts (fig. 55), of New York, bred a cross between Belleville's 1877 and Herreshoff's 1890 boiler, that while

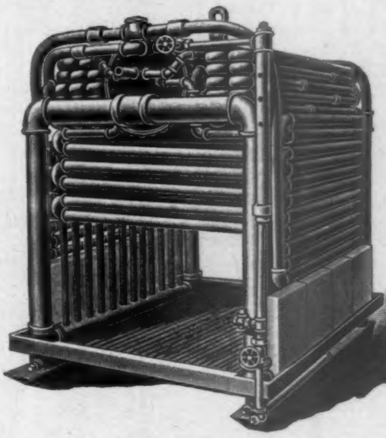


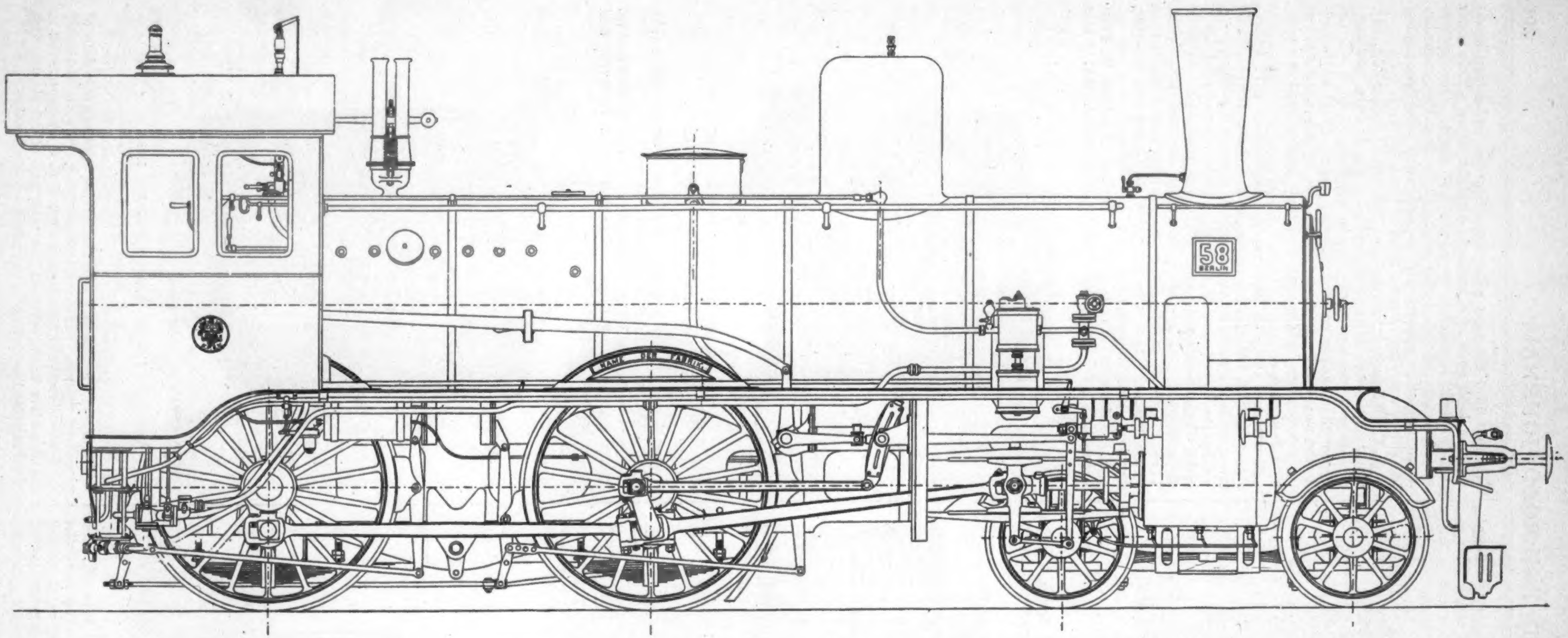
Fig. 55.—ROBERTS' BOILER, 1887.
Trade Circular Issued in New York.

"favoring" both its parents, developed outside down-take pipes of its own. Made of pipes and fittings.

Almy used straight pipes connected up with elbows and return bends to an overhead steam and water reservoir and bottom connecting pipes (fig. 56).

Fig. 56.—ALMY'S BOILER, 1890.
U. S. Patent No. 434,227.

The above are samples of some of the best aggregations of pipes and fittings. The least objectionable are those having the fewest bends and the least length of pipe, in proportion to the diameters used, between the inlet and outlet of each unit of circulation.



SIDE ELEVATION OF STANDARD EXPRESS PASSENGER LOCOMOTIVE FOR THE STATE RAILWAYS OF HANOVER.

EXPRESS PASSENGER LOCOMOTIVE FOR THE STATE RAILWAYS OF HANOVER.

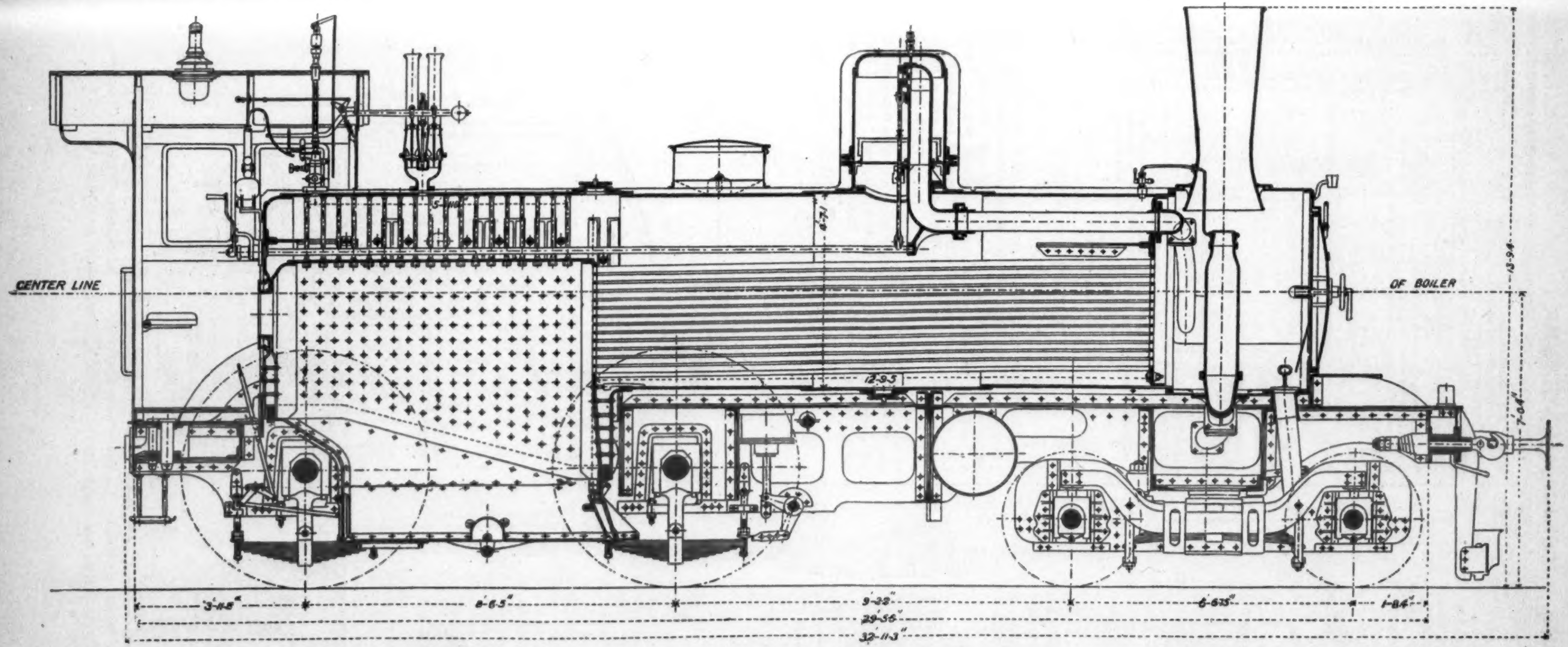
We present herewith engravings of the standard express passenger locomotive that is in use on the State Railways of Hanover. The locomotive was designed by Mr. August von Borries, the Locomotive Superintendent of the road, whose work in connection with compound locomotives is so well known. This engine is, in fact, identical with the compound locomotives in use, with the exception that the driving-wheels of the latter have a diameter of 6 ft. 6 in. instead of 5 ft. 8.8 in., as in the case of the engine illustrated.

This standard locomotive is used on roads differing widely in the character of the profile, varying from a level track to grades of 1 in 64. During the months of January and February of this year the average coal consumption on a practically level division was 37 lbs. per mile with loads averaging 110 tons. This coal consumption includes that used for the steam-heating, which was taken from the engine. The average speed, including stops and slowing-down points, is 37.28 miles per hour for local trains and 46.6 miles for express trains. The train load rating of these engines for level divisions is 240 tons, while for grades of 1 in 100 the rating is 160 tons, and for grades of 1 in 64 it is 120 tons. At full speed the engineers are expected to cut off steam at one-fifth stroke.

The wheel centres for the driving-wheels are of cast steel, and the fire-box is of copper. The engine is equipped with the driver-brakes, operated by the cylinder shown just ahead of the rear driving-axle on the longitudinal section, a shoe being placed on each side of each wheel and so interfulcrumed that all come to a bearing at the same time. The driving-springs are underhung, and no equalizer is used, so that there is something more than 6 per cent. more weight on the back driving-spring than on the forward one.

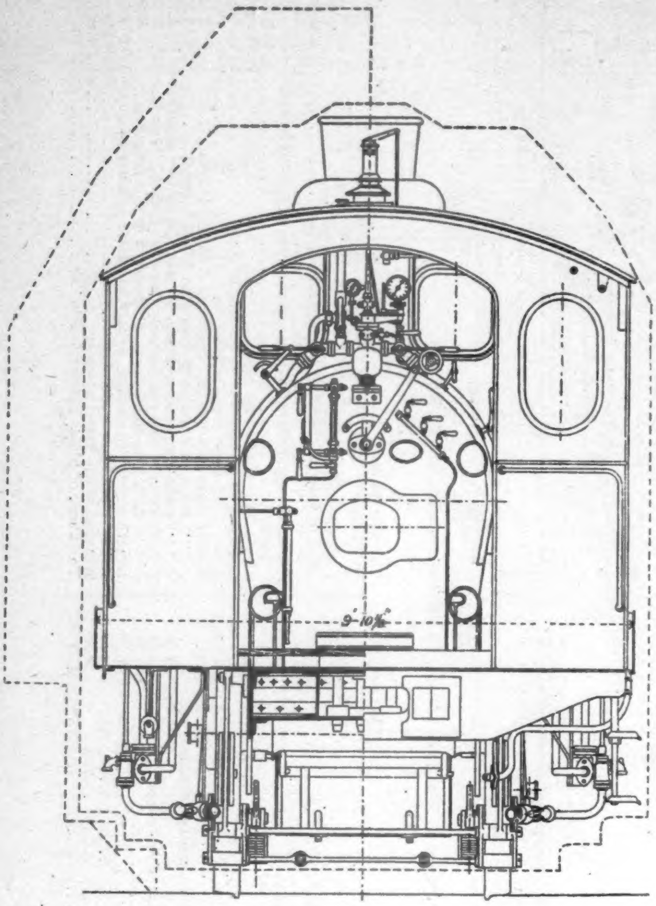
The following is a list of the principal dimensions of this locomotive :

Weight on back pair of driver springs in working order....	24,750 lbs.
" " front " " " " " " "	23,154 lbs.
Weight on truck springs in working order	27,742 lbs.
" of back pair of driving-wheels and axle......... ..	6,820 lbs.
" " forward pair of driving-wheels and axle.........	7,986 lbs.
Total adhesive weight of back pair of driving wheels in working order	31,570 lbs.
Total adhesive weight of forward pair of driving-wheels in working order	31,140 lbs.
Weight of back pair of truck wheels and axle...............	4,983 lbs.
" " front " " " " " "	4,950 lbs.
Total weight on back truck wheels in working order......	18,810 lbs.
" " " forward truck wheels in working order....	18,865 lbs.
" " " truck wheel tires	37,675 lbs.
Distance between driving-wheel centres	8 ft. 6.4 in.
" from centre of cylinder to centre of forward driving-wheel.............	12 ft. 3 6 in.
Length of firebox (inside)................................	7 ft. 2 6 in.
Width " "	3 ft. 3.75 in.



LONGITUDINAL SECTION OF STANDARD EXPRESS PASSENGER LOCOMOTIVE FOR THE STATE RAILWAYS OF HANOVER.

Depth of fire-box	5 ft. 1.8 in.
Type " "	Belpaire.
Material of inside of fire-box	Copper.
Water space, side of fire-box	2.7 in.
" " back " "	4.9 in.
" " front " "	4.9 in.
Thickness of plates outside of shell	0.55 in.
" " side sheets of inside of fire-box	0.63 in.
" " crown-sheet	0.63 in.
" " back tube-sheet	1 1 in.
" " front "	1 in.
How crown-sheet is stayed	Staybolts with head on under side.
Inside diameter of dome	2 ft. 1.6 in.
Thickness of shell of dome	.4 in.
Height of dome	3 ft. 3⅜ in.
Maximum working pressure per sq. in	180 lbs.
Kind of grate	Inclined.
Grate area	24.75 sq. ft.
Heating surface in fire-box	96 34 sq. ft.
" " " tubes	1194.30 sq. ft.
Total heating surface	1290.64 sq. ft.
Single or double exhaust nozzle	Single.
Diameter of exhaust nozzle	5.35 in. with .15 in. bridge.
Smallest inside diameter of smoke-stack	15.75 in.
Inside diameter of stack at top	19.7 in.
Height from top of rail to top of smoke-stack	13 ft. 9.4 in.
" " " " " " the centre of the boiler	7 ft. .4 in.
Weight of tender, empty	34,760 lbs.
Number of wheels under tender	6
Size of tender journals	4.8 diam., 7.87 in. long.
Length of connecting-rod from centre to centre of bearings	8 ft. 2 4 in.
Transverse distance from centre to centre of cylinders	6 ft. 8.3 in.
Diameter of cylinder	18.1 in.
Stroke of piston	23.6 in.
Horizontal thickness of piston	3.94 in.
Diameter of piston rod	3 in.
Size of steam port	13.78 in. × 1.3 in.
Size of exhaust port	13.78 in. × 2.56 in.
Greatest travel of valve forward	4.78 in.
" " " " backward	4.58 in.
Inside lap of valve	.04 in.
Lead of valve full stroke, front	.13 in.
" " " " " back	.16 in.
Throw of upper end of reverse screw from full front to full back	14.17 in.
Sectional area of steam pipe	23.75 sq. in.
Diameter of driving-wheels outside of tires	5 ft. 8.8 in.
" " front truck wheels	3 ft. 3⅜ in.
Size of main axle journal, diameter, 7.28 in.; length	7 in.
" " truck axle journals, diameter, 5.5 in.; length	7.87 in.
" " main crank-pin journals, diameter, 4.33 in.; length	3.93 in.
" " forward side-rod journal, diameter, 2.75 in.; length	2.36 in.
" " back side-rod journal, diameter, 2.75 in.; length	2.36 in.
Length of driving springs, centre to centre of hangers	3 ft. 1.4 in.
Boiler, straight or wagon top	Straight.
Material of the barrel of boiler	Mild steel.
Thickness of plates in barrel of boiler	.55 in.

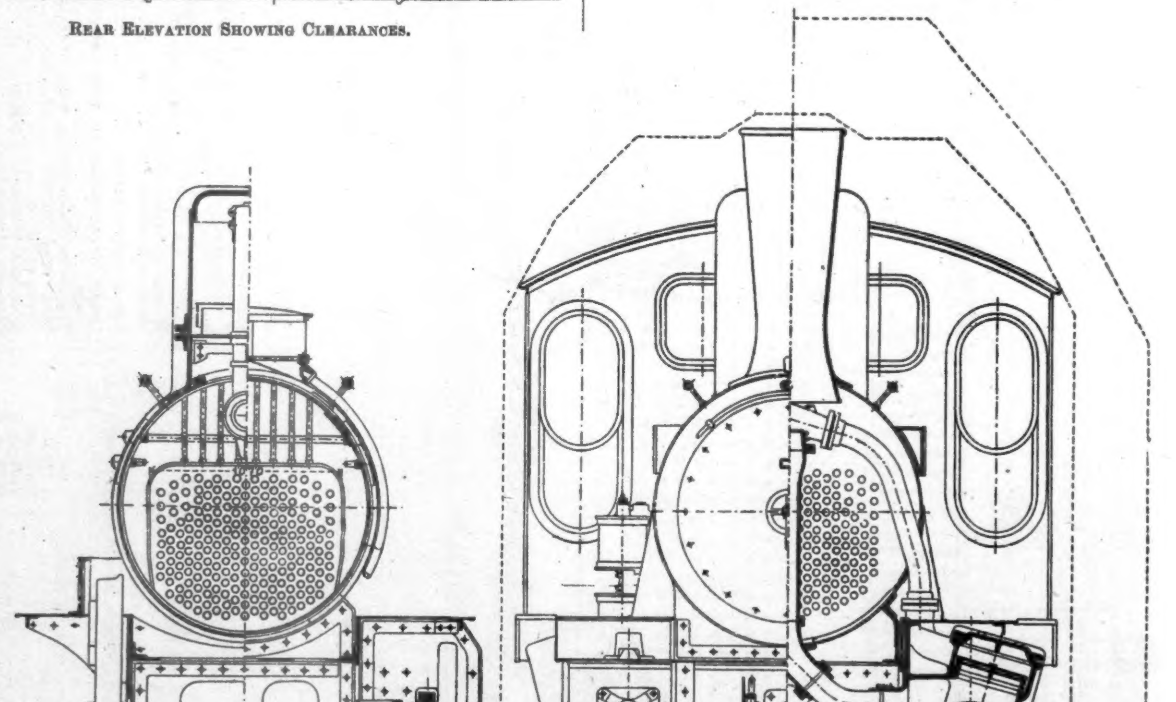


REAR ELEVATION SHOWING CLEARANCES.

Kind of horizontal seams	Double plated.
" " circumferential seams	" rivetted
Inside diameter of barrel	4 ft. 6 in.
Material of tubes	Wrought iron.
Number " "	219
Diameter of tubes, outside	1.8 in.
" " " inside	1.6 in.
Distance between centre of tubes	2.5 in.
Length of tubes over tube plates	12 ft. 11.6 in.
Distance from center to center of truck wheels	6 ft. 6.75 in.
Water capacity of tank	3,170 gals.
Coal capacity of tender	11,000 lbs.
Total wheel base of engine and tender	43 ft. 4.65 in.
" length of engine and tender over all	53 ft. 5.5 in.
Height of centre of draft and buffing rigging above top of rail	3 ft. 5 3 in.
Length of truck spring, centre to centre	3 ft. 11.4 in.
" " smoke-box	3 ft. 4.3 in.
Height of bottom of ash-pan above top of rail	1 ft. 1.6 in.
Depth of ash-pan, front	1 ft. 5.7 in.
Number of safety valves	2 (1 Ramsbottom.)
Diameter of safety valves	2.83 in.
Distance centre to centre of buffers	5 ft. 8.8 in.
Breadth of engine at widest point	9 ft. 10½ in.
Height of roof of cab above top of rail	12 ft. 3.4 in.
" " " " " " foot plate	6 ft. 2.2 in.
Breadth of driving wheel tires	5.3 in.
Height of running board above top of rail	5 ft. 0.6 in.
Distance from boiler head to back of foot plate	2 ft. 11.5 in.
" " top of crown-sheet to inside of boiler shell.	1 ft. 6.3 in.
Transverse distance from centre to centre of driver springs.	3 ft. 10.5 in.
" " between inside of driving-wheel tires.	4 ft. 5.5 in.

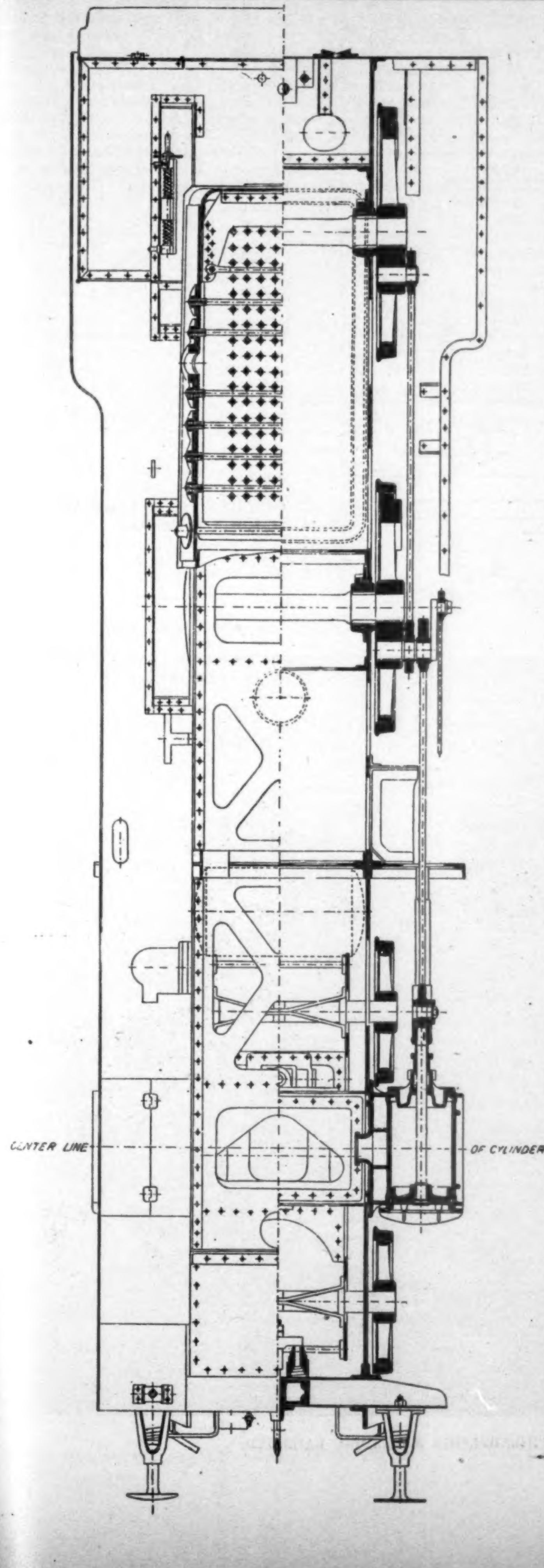
RACK RAILWAYS.

IT often happens that old ideas of inventions patented many years ago, which seem to have sunk into oblivion, are, half a century later, revived under a new form, and become valuable acquisitions to the industrial and scientific world. Such has been the case with rack railways. The first rack railway was built in 1811 near Leeds, by Blenkinsop. It was a mistaken conception, if you like, but in it was, nevertheless, the germ of the invention which has made mountainous districts accessible by rail to tourists, and in many cases connected them with main lines. The engineers of the early part of the century were under the impression that the adhesion between the



HALF SECTION AT FRONT DRIVER. HALF SECTION AT GUIDES. HALF FRONT ELEVATION. HALF SECTION THROUGH CYLINDERS.

STANDARD EXPRESS PASSENGER LOCOMOTIVE ON STATE RAILWAYS OF HANOVER.



HALF PLAN AND HORIZONTAL SECTION OF STANDARD EXPRESS PASSENGER LOCOMOTIVE ON THE STATE RAILWAYS OF HANOVER.

ordinary plain wheel and rail would not be sufficient to effect the propulsion of the locomotive, then in its infancy. Blackett, in 1811, showed that toothed wheels and racks were needless for this purpose Fifty-nine years were to elapse before Sylvester Marsh, in the United States, and Riggenbach, in Switzerland, were to revive the idea and assign it its proper place and use—*i.e.*, in those heavy gradient railways where the adhesion of the ordinary locomotive rendered it entirely inadequate to haul any load worth mentioning besides itself.

The Mount Washington Railway, built by Sylvester Marsh, is very similar to that constructed on the Righi by Messrs. Riggenbach & Naeff. It should be mentioned that Sylvester Marsh had first attempted to work Fell's central rail arrangement, but soon abandoned it, substituting for the central rail a rack. The gradients on either railway are often 1 in 4; on the average the inclination of the gradients is 11 in 50.

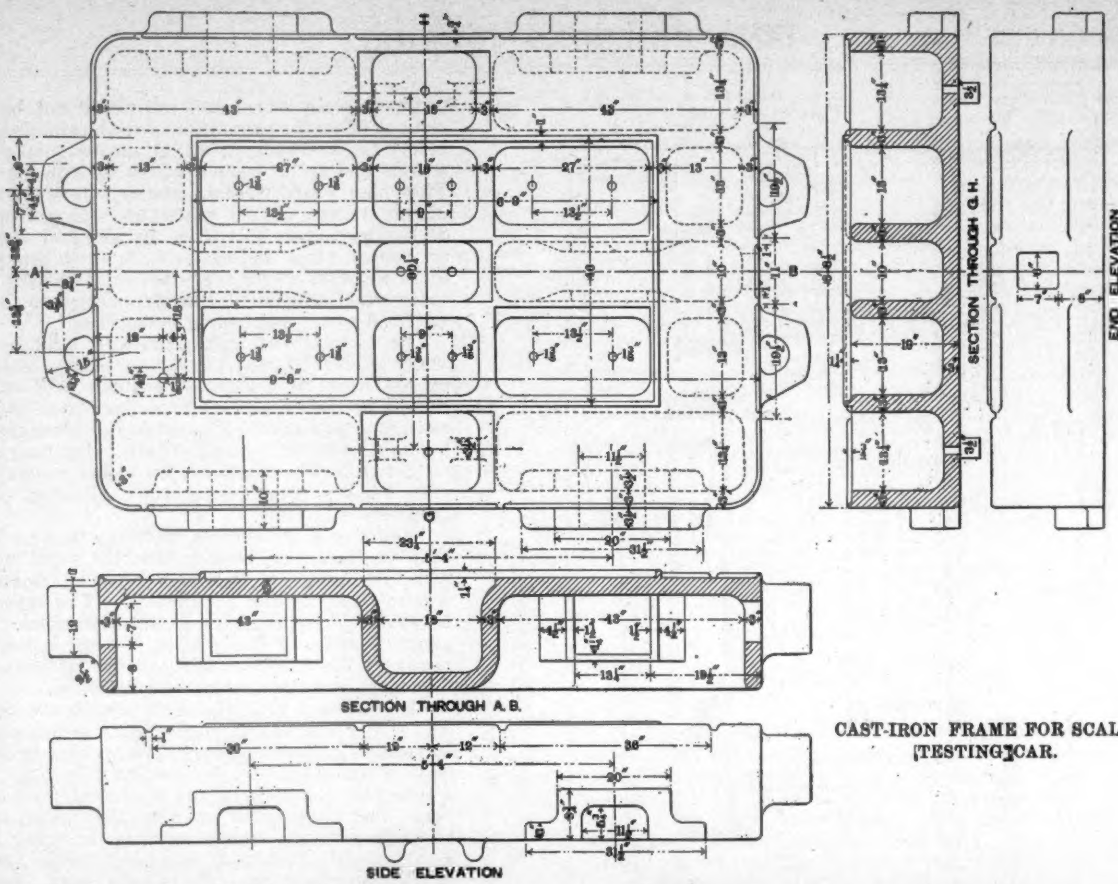
The Righi was a success, and since then no fewer than 25 lines have been built in the world on this principle. Most of them are found in Germany, Austro-Hungary and Switzerland. The aggregate length of these railways is over 100 miles. The gauge is either 4 ft. 8½ in. or 1 metre. Steep inclines of 1 in 5 are met with on the Höllenthal in Germany, and the Laufen in Switzerland.

The rack used by Riggenbach is really a wrought-iron ladder laid centrally between the ordinary rails. It consists of parallel channel irons kept apart by stays of round iron, which constitute the teeth, into which gear the teeth of the wheels on the engine run. The first engine had a vertical boiler, set at an angle with the frames, so that the water level would remain horizontal, whatever the inclination of the road might be. The wheels were loose on their axles, but the toothed wheel was keyed on the middle of the rear axle. Motion was transmitted to it by intermediate spur wheels. In subsequent applications the toothed wheels were mounted on a blind axle, for in the previous arrangement it occurred that the ordinary wheels wearing on the tread would interfere with the proper working of the toothed wheel, which gears simply with the rack. In all engines built afterward horizontal boilers were adopted, but arranged in such a manner that the level of the water should always remain horizontal or nearly so.

The idea naturally occurred that the wheels which run on the ordinary rails might be coupled and actuated by steam. This has been done on nine of the railways built according to Riggenbach's plans. But the merit to have carried this new idea to its fullest extent and improved the rack belongs to M. Roman Abt, of Lucerne. During the last nine years the Abt system has made wonderful progress. No fewer than 19 railways have been built on the Abt system, representing an aggregate length of 194 miles. The longest are the Hartz Railway, in Germany, 18 miles; the Rama Serajewo, in Bosnia, 42 miles; a section of the Transandine, in South America, 31 miles; San Domingo, West Indies, 22 miles. One of these railways—that of Mont Salies, in France—is an electric one; 1 in 5 gradients, as at Aix-les-Bains, are not infrequent.

The difference between Abt's and Riggenbach's systems consists in the construction of the rack and the fuller utilization of the adhesive weight on the wheels running on the ordinary rails. There are two independent groups of cylinders. Those inside actuate the spur wheels keyed on an intermediate shaft. The outside ones drive the ordinary wheels in the usual manner, these wheels being, of course, coupled. On the portions of the lines which are not too steep the outside cylinders alone are worked; on the heavy gradients, the inside or both inside and outside cylinders are used.

The rack consists of parallel steel bars supported by chairs resting on metallic sleepers. The steel bars are cut out so as to form suitable racks, but the teeth of one bar are not opposite those of the other, but opposite the space between two teeth of it. This arrangement necessitates the employment on the engine of wheels with stepped teeth, but it reduces friction and ensures that the spur wheels are always in contact with one or



CAST-IRON FRAME FOR SCALE-TESTING CAR.

SCALE-TESTING CAR FOR PHILADELPHIA & READING RAILROAD.

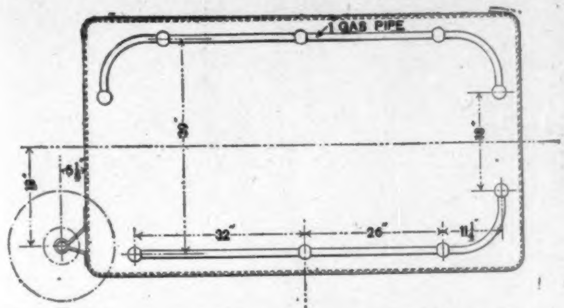
two of the rack bars, which was not the case in the Riggenbach system. The advantages are: first, the rack is easier to make and lay down with accuracy than the ladder arrangement of Riggenbach. The joints, although insistent, can for each rack bar be laid in alternate chairs, so as to keep continuity and the strength of the rack unimpaired; second, much sharper curves can be used. In the Riggenbach system they could not be less than 9 chains radius; 5 chain curves are frequent on the lines laid according to the Abt system. There is no necessity to have specially made parts for curves, as is the case with Riggenbach's rack. The slight wear which takes place on the teeth at first after the line is opened to the traffic compensates for the difference of curvature. The experience gained on the Hartz Railway goes to show that the rack teeth wear 1 millimetre in 150 years, and the spur wheels last 12 years. The Riggenbach spur wheel lasts only two years.* Third, the number of rack bars determines the weight of the trains which can be hauled on such a track; a greater speed is possible, as there are always teeth in contact with the racks, and consequently no shocks, as in the Riggenbach system. Five miles an hour on the latter gives rise to hammer blows between the wheel and rack teeth, whereas in the Abt system a speed of 15 miles an hour is obtained without shocks or noise. The Abt system has been, so far, a grand success, and it will, no doubt, receive more extended application. The Beyrout-Damascus Railway, 86 miles long, will be on the Abt system.—*Railway Herald.*

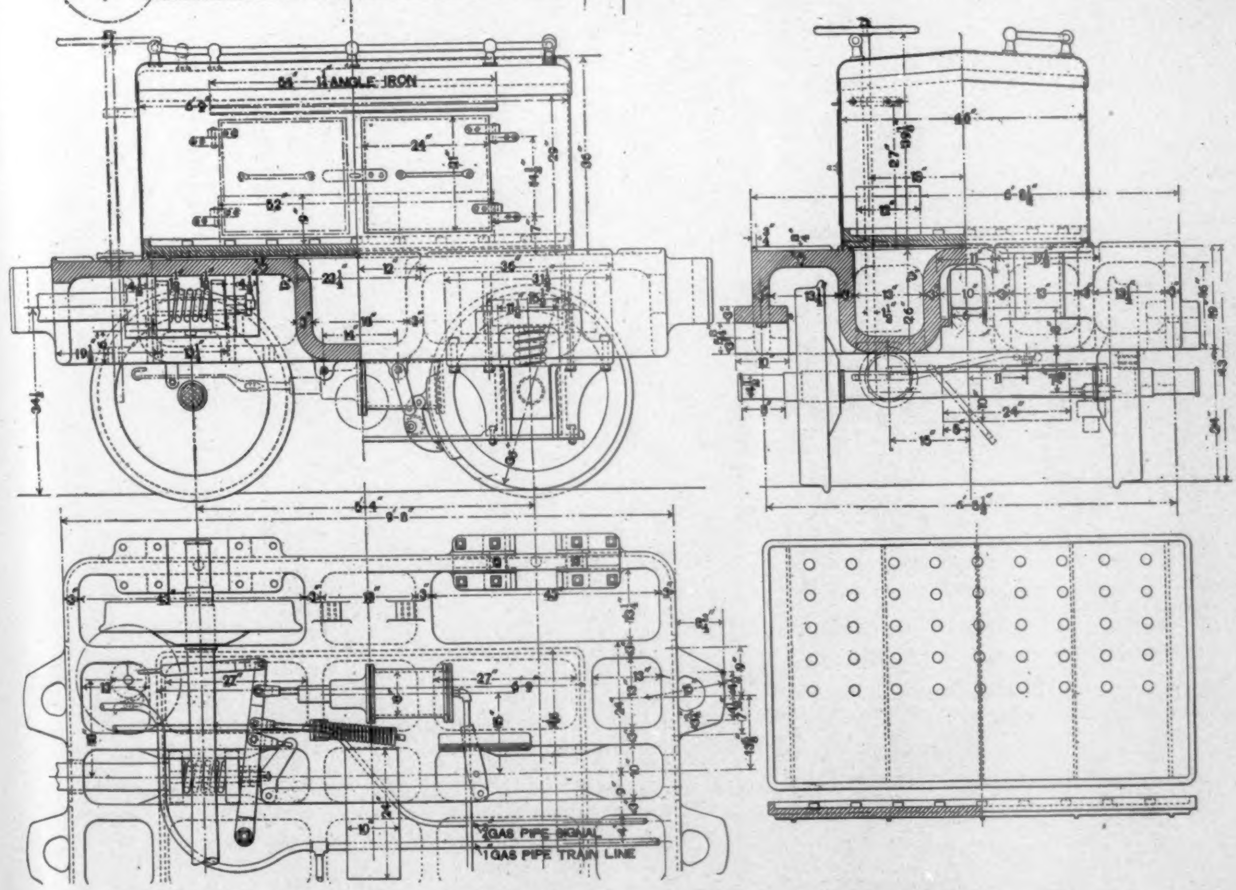
* Albert Schneider, in *Organ für Fortschritte*, for March 21, 1894.

SCALE-TESTING CAR, PHILADELPHIA & READING RAILROAD.

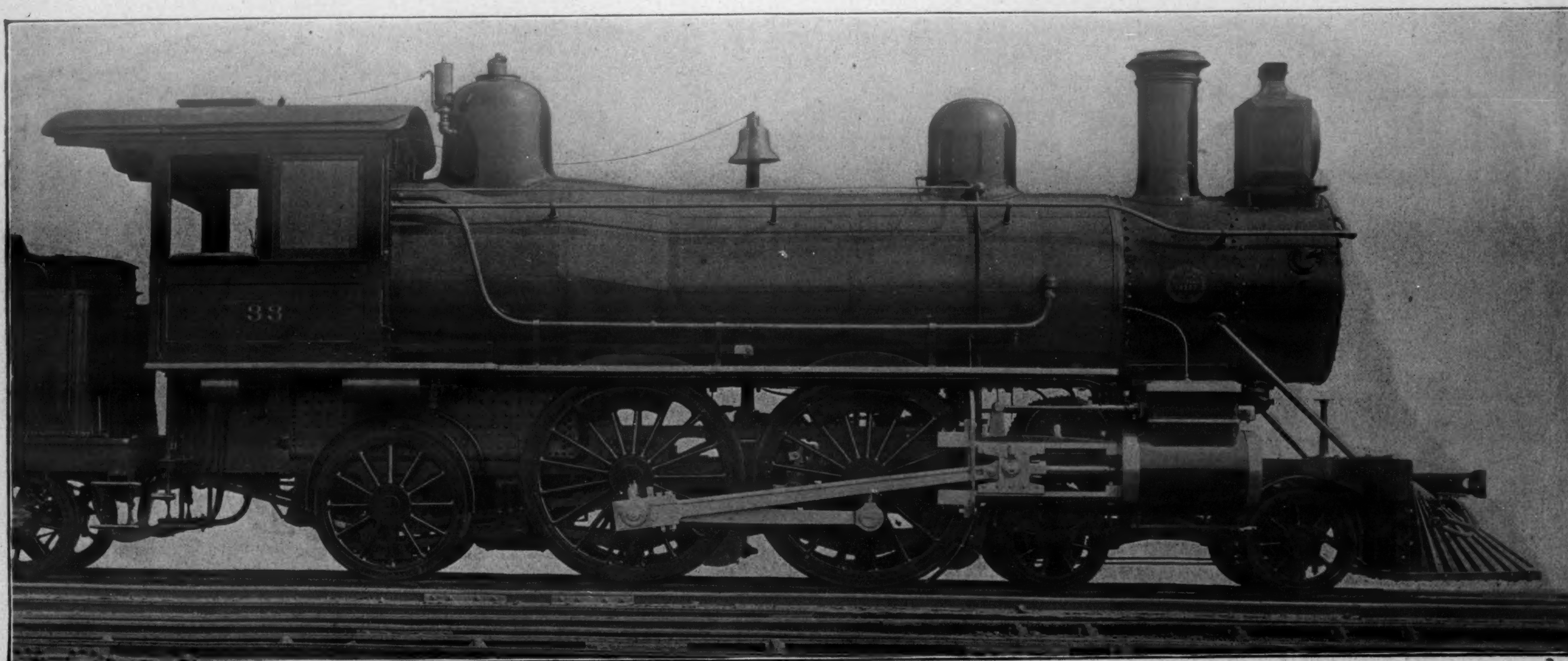
It is well understood by those who have even a superficial knowledge of weighing scales of any kind, that they are continually getting out of accurate adjustment, and this whether they are in use or not. As the coarseness of the workmanship and the loads to be weighed increase, this liability to error increases, and for accurate work it is absolutely essential that readjustments should be continually made. In order to meet this condition, the Philadelphia & Reading Railroad have built, at their Reading shops, a scale-testing car, illustrations of which are herewith presented.

The car has been in service for some time, and is giving entire satisfaction, except that it rocks fore and aft when running at the rear end of a train at a high speed. It is expected, however, that this trouble will be partially overcome by the use of stiffer springs. The body, which is shown by a separate illustration in very complete detail, is composed of a ribbed casting with metal 3 in. thick throughout and weighing 20,850 lbs. Those pockets which open to the top are filled with solid blocks of cast iron having a total weight of about 10,000 lbs. On this casting are all of the lugs and bosses required for securing the several attachments, and include the bumpers at the ends. Over the top of the body casting there is bolted a plate weighing about 1 ton, to which is riveted the heavy sheet-iron house, and which is also provided with a number of lugs that serve to keep from shifting forty-five 50-lb. weights, all scaled to U. S. standard, and which are used to test small scales. In the sheet-iron house are kept various necessary tools, extra springs, journal bearings, brake-shoes, etc., all of which are in the car when it is scaled on the standard scales at Pottstown, Pa., once every month, or oftener, if necessary. In case of the breakage of any of the above parts, the old is put into the house, and the new, taken therefrom, put into service, and the weight thus kept as near constant as possible. To the under side of the body are bolted the pedestals and brake-cylinders, the only important fixtures of the car which are not a part of the body casting. The car is carried by four 36-in. steel tired Boise wheels mounted on steel axles having $4\frac{1}{4} \times 8$-in. journals, the wheel-base being 5 ft. 4 in. The car is equipped with National Hollow brake-

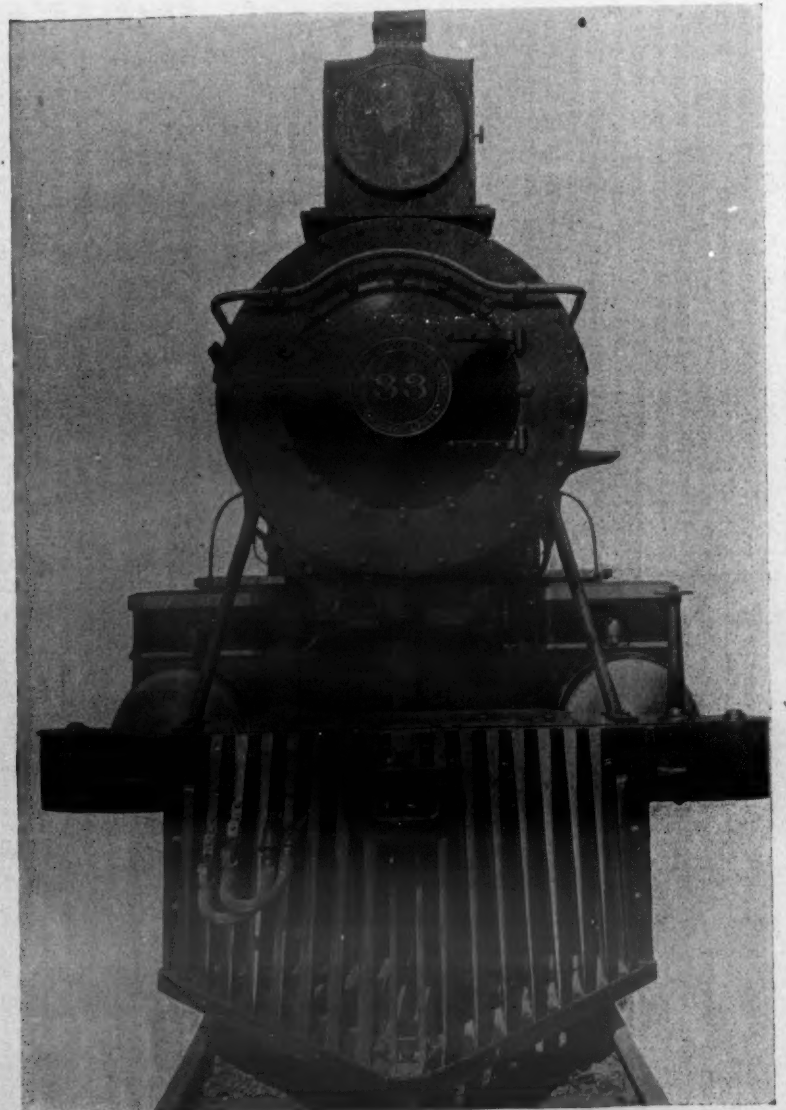


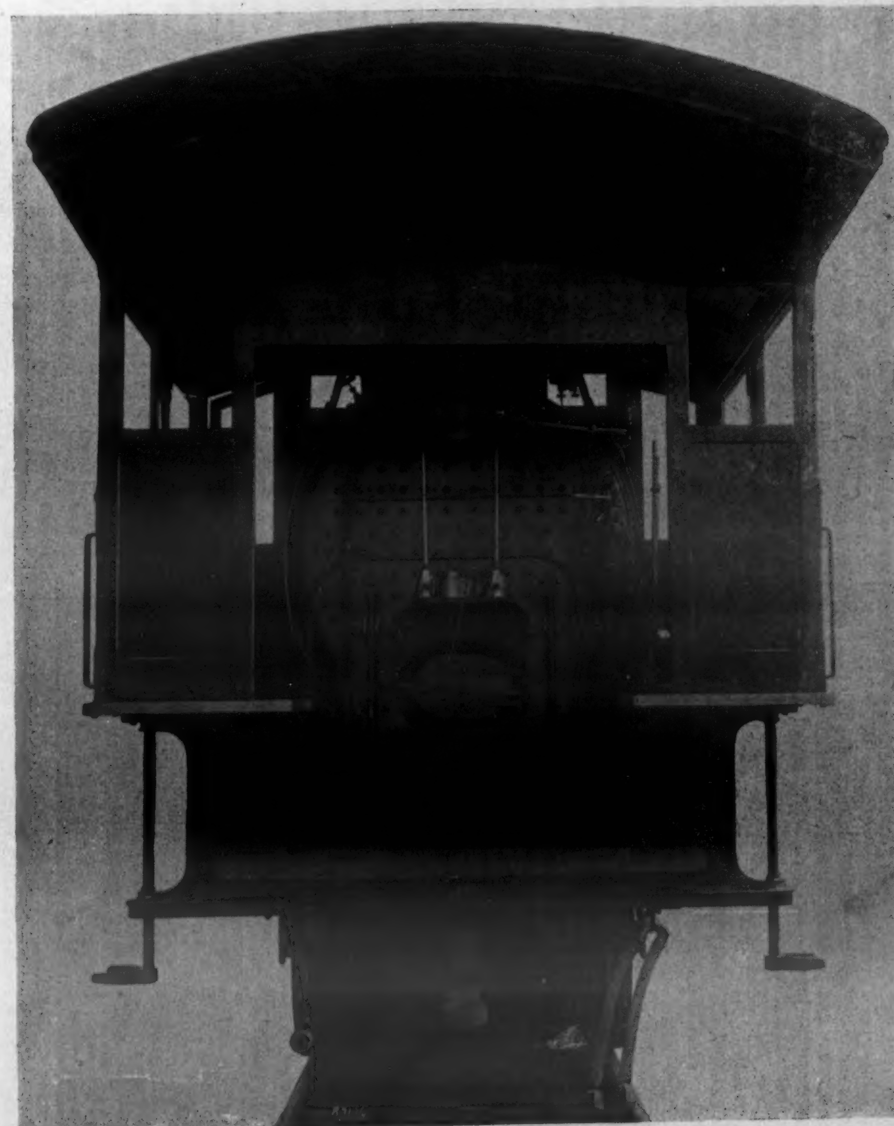


SCALE-TESTING CAR FOR THE PHILADELPHIA & READING RAILROAD.



PASSENGER LOCOMOTIVE FOR THE CONCORD & MONTREAL RAILROAD, BUILT BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA, PA.





FRONT AND REAR VIEWS OF EXPRESS PASSENGER LOCOMOTIVE, BUILT BY THE BALDWIN LOCOMOTIVE WORKS FOR THE CONCORD & MONTREAL RAILROAD.

beams, Westinghouse air-brake and signal-pipe, and the Gould automatic freight car couplers. The weight of the car when ready for service is 20 gross tons.

The half-tone reproduction of the photograph shows the car ready for service, except that the bar, which is shown thrust through the hand-wheel, is not a part of the car, and should have been removed before the photograph was taken.

PASSENGER LOCOMOTIVE FOR THE CONCORD & MONTREAL RAILROAD.

Our full-page illustration and front and back-end views represent an engine just completed for this road, which is of a design that has been recently adopted for a number of locomotives by the Baldwin Locomotive Works. The chief peculiarity consists in locating both the driving-axles in front of the fire-box, and carrying the back end on a pair of trailing wheels. It will be remembered that the engine *Columbia*, which was exhibited by this company at the Chicago Exhibition last year, was of this general type, but was compounded and had a pair of pony wheels instead of a four-wheeled truck.

The plan has much to recommend it, as it permits the driving-wheels being placed as near together as their flanges will allow, and with slightly different proportions at the back end the fire-box could be widened out to any desired width.

The following are the principal weights and dimensions of the engine :

Cylinders, diameter	19 in.
Piston stroke	24 in.
Driving-wheels, diameter outside of tires	70 in.
" " " of centres	63 in.
Driving-wheel centres of cast steel, tires held by retaining rings.	
Boiler, wagon-top.	
Working pressure	170 lbs.
Boiler, diameter	60 in.
Fire-box	89⅝ in. × 42 in.
Tubes, number	234
" diameter	2 in.
" length	14 ft.
Weight in working order, about	128,000 lbs.
" on driving-wheels	74,500 lbs.
" " front truck	31,500 lbs.
" " trailing wheels	22,000 lbs.
Total wheelbase of engine	23 ft. 5 in.
Rigid wheelbase (including trailing wheels)	12 ft. 6 in.
Spread of coupled wheels	6 ft. 1 in.
Driving axle journals	8 × 10
Engine truck journals	5 × 9
Trailing wheel journals	6½ × 10
Tender journals	4½ × 8
Diameter of engine truck wheels	33 in.
" " trailing wheels	50 in.
" " tender wheels	36 in.
Tank capacity	4,000 galls.

This locomotive is fitted with Westinghouse air brake on driving-wheels, tender and train ; Westinghouse air signal ; consolidated steam-heating appliances ; Sherbourne sander ; Columbia metallic packing ; Nathan sight-feed lubricator ; Hancock inspirators. The engine truck and tender wheels are the Vauclain wrought-iron centre steel-tired wheels manufactured by the Standard Steel Works.

MEETING OF MECHANICAL ENGINEERS.

The last monthly meeting of Mechanical Engineers in New York for the season was held on the evening of May 8, at the house of the American Society of Mechanical Engineers, No. 12 West Thirty-first Street. Mr. E. F. C. Davis, the President of the Society, presided. Mr. F. W. Dean read the paper of the evening, which was upon

THE EFFICIENCY OF COMPOUND LOCOMOTIVES.

The compounding of locomotives presents to the railroad companies of this country the greatest means of fuel economy that has been placed within their reach, and it is fair to assume that this is the greatest of all the economies that can be carried out by railroads. Long since used in engines for all other purposes with marked success, the compound principle in using steam was unused in locomotives until recently, especially in this country. Of late, however, the country has been somewhat flooded with compounds, some of very inferior designs. The result of this has undoubtedly been to cause a reaction, several compounds have been changed to simple engines, and many railroad men are either in a sceptical state of mind or condemn such locomotives in an unqualified manner. Wherever this condition exists, it can always be traced to an experience with locomotives having such bad qualities, that their use was simply intolerable. Fortunately, there are a sufficient number that are proving to be unobjectionable, and are so highly advantageous in many ways, that their continued use is assured and will be gradually extended. There is nothing in which the expression "survival of the fittest" will apply with more pertinence than to compound locomotives. Persons either possessing such exceptions or being intimately acquainted with them never hesitate to say that they are the locomotives of the future, especially for freight, elevated railway, and suburban work. A type of engine that can clearly save fully one-quarter of the coal now used by simple locomotives, that materially reduces water consumption, diminishes boiler and slide-valve repairs, reduces smoke, cinders, and the fire risk, that steams better than the simple engine in hard places, without a necessary increase of any kind of repairs, must surely become the favorite as soon as people know which design to select.

Your committee has asked me to speak particularly of the *efficiency* of compound locomotives. This I propose to do briefly and as clearly as possible, and I shall begin with a statement of the reasons why a compound locomotive that is properly designed will save steam compared with the best simple locomotive, no matter what kind of service is considered.

1. The steam can be more conveniently used with great expansion, and therefore high steam pressure can be more advantageously utilized.

2. Division of the expansion between two cylinders diminishes condensation in both cylinders by reducing the range of temperature in each cylinder.

3. Division of expansion between two cylinders renders it possible to evaporate, or re-heat, a portion of the moisture in the exhaust of the first cylinder, and thus render it capable of doing work in the second cylinder. As this can be done in the locomotive with waste gases the gain is all profit. By using the proper kind of receiver this is an effective means of economy.

4. Steam that leaks through the valve of the first cylinder is, in a properly designed locomotive, worked expansively in the second cylinder.

5. Steam that is re-evaporated toward the end of the high-pressure piston-stroke, too late to work expansively, instead of being exhausted to the atmosphere as in the simple locomotive, is worked expansively in the low-pressure cylinder.

Concerning the first reason, the expansion in the compound locomotive can be secured with a later cut-off than in the simple locomotive, and with this comes a wider port opening and less wire drawing of the steam. It is feasible to expand steam in a single cylinder by cutting off early, but such efforts have always resulted in wastefulness by great condensation, thus giving rise to the familiar expression "expansive working is expensive working." D. K. Clark showed as early as 1850 that a cut-off of about one-third stroke in a simple engine is the most economical, and the same thing has been recently shown by Professor Goss in this country. So that if a high degree of expansion is used in the simple locomotive it means extravagance in steam, although it may save some coal by low terminal pressure and gentle exhaust action on the fire. The compound locomotive, however, saves 15 to 20 per cent. of steam, and above this saves coal by its low terminal pressure and gentle exhaust.

Concerning range of temperature, in certain typical cases in my possession the temperatures and ranges were as follows :

SIMPLE.		COMPOUND.			
Initial temp.	374°	H.P.	368°	L.P.	312°
Lower	230°	"	298°	"	230°
Range	144°	"	70°	"	82°

In these cases the simple locomotive used 27¼ lbs. of feed-water per I.H.P. per hour and the compound 19½ lbs., producing a saving of 29 per cent. This remarkable saving is attributable only to the small ranges of temperature in the cylinders with resultant small condensation, and to the reheating receiver, for the total expansion was the same in both cases.

In simple locomotives the condensation in cylinders sometimes amounts to as much as 60 per cent. of the total steam used, and in the case of a simple locomotive with which I have experimented, where the passages were well protected, the condensation was 38 per cent.

The effect of a re-heater is rather difficult to determine in a locomotive, and of course no rise in temperature or superheating would be shown until all of the moisture had been converted into steam. As there is much moisture in exhaust steam it is not likely that it will be all dried out by the receiver of a locomotive. In a pumping engine, however, such difficulty disappears, and in a Leavitt pumping engine at the Boston Water-Works, while the pressure in the low-pressure

steam-chest was equal to that of the atmosphere, the temperature instead of being 212° was 306°, showing the remarkable super-heating of 94°. As a compound locomotive receiver is bathed in gases of 550° to 600°, while the temperature of the moist steam within has a temperature of only some 280°, it is unnecessary to argue that some re-evaporation takes place. When we remember the great capacity of the metal of a steam cylinder to condense and re-evaporate, we have ample reason for the belief that a receiver having a temperature fully 200° higher than that of any locomotive cylinder, has a much greater capacity for evaporating moisture than a cylinder. It is clear, from these considerations, that a receiver in the smoke-box of a locomotive is of the greatest importance in promoting economy.

In the fourth reason for the economy of a compound locomotive I have stated that the leakage by the high-pressure valve should pass into the low-pressure cylinder, and there worked expansively. This is necessarily so in the two-cylinder engine, but in some four-cylinder locomotives, with a single valve to two of the cylinders, leakage may pass directly from the high-pressure cylinder, or even the boiler, to the atmosphere.

While I have pointed out the economical advantages of compounding, I must not ignore the losses to which the compound is subject. These losses have in cases converted compounds into more wasteful engines than simples.

I will take up these losses as they occur.

The first is that due to the imperfections of the link motion which are strongly brought out in the high-pressure cylinder. These imperfections are great in simple engines also, notwithstanding the protestations of some of my locomotive friends, but in the high-presure cylinder of the compound, as compression begins on the steam of receiver pressure, compression is likely to be excessive, and reduces the area of the indicator diagram seriously, and in early cut-offs at ordinary speeds, even, a loop is frequently formed showing negative work, thus reducing the net work. This is one reason why many compounds at certain points of cut-off do much more work in the low-pressure cylinder than in the high. It also furnishes a part of the reason why some compound locomotives are less economical, in relation to the simple engine, in light work than in heavy. In the latter case the point of cut-off is sufficiently late to avoid excessive compression and a loop in the diagram.

The usual remedies for this defect are, inside clearance to the slide-valve, and large clearance volume in the cylinder. The former causes the exhaust to close later, thus trapping in less steam in the clearance spaces, and the latter gives a larger volume to fill by compressed steam and thus reduces the maximum pressure. There is another remedy that ought to be applied in addition, as follows: The high-pressure valve should be set so as to give negative lead in full gear, and to give zero lead when cutting off at about 45 per cent. of the stroke. Slipping the eccentrics back sufficiently to accomplish this, delays the beginning of compression, and therefore its maximum amount.

Another loss, which is often great, is that between the cylinders, causing the combined indicator diagram to have a large gap between the bottom of the high-pressure and top of the low-pressure cards. This loss is so great in many cases as to amount to some 30 per cent. of the possible work of the steam after high-pressure release, and will nullify all gains that may come from compounding. It is probable that less than half a dozen compound locomotives in the country have this loss so small as to make it, when coupled with another phenomenon, virtually nothing. The latter will be noticed presently.

The loss between the cylinders is so insidious, so to speak, and so little comprehended, that it should be dwelt upon sufficiently to make its causes and nature clear. It cannot be done away with, even in slow-running pumping engines, for even there some work must be absorbed in transferring the steam from one cylinder to the other. In addition to this cause the various resistances produced by obstructions and abrupt changes in direction of the steam passages are to be noted. The steam in passing out of the first cylinder, through the intercepting valve, where this is used, and through the open port of the low-pressure cylinder, is considerably retarded and a great loss of pressure is produced. Engines having piston-valves suffer much from this loss because the steam has to pass through gratings which form the ports. Engines that have the intercepting valve on the low-pressure side are much subject to this loss, because the steam is rapidly drawn from the receiver by the low-pressure piston through this restricted opening. If this valve is on the high-pressure side the steam passes through it only as rapidly as it escapes from the small cylinder, and this is only some one-half to one-third as rapidly as it is drawn into the large cylinder. This shows the importance of placing the intercepting valve as near the high-pressure cylinder as possible.

The type of engine that can be used at will as a simple engine, is in general considerably subject to this loss, for the changing valve forms tortuous passages and abrupt obstructions when the engine is compounded. In this case also, the valve should be near the high-pressure side.

I should not omit to notice a loss seldom thought of—viz., that due to the back pressure on the low-pressure piston. This piston always has a larger area than the combined areas of the two pistons of the equivalent simple engine. Unless the back pressure per square inch on the low-pressure piston is less than on the simple pistons, in proportion to the greater piston area, it is evident that the work of the back pressure is greater in the compound than in the simple engine. In general, I think the back pressure will be found to be proportionately less than in the simple engine, but this possible loss should furnish caution against over-cylindering a compound locomotive, especially on the low-pressure side, and particularly for high speeds. This is an argument for obtaining large power by means of large high-pressure cylinders, and indirectly for the cylinder ratio of 2 to 1, or thereabout, for a passenger engine.

Having considered all the losses to which a compound is subject, we are in a position to appreciate the reason why certain compound locomotives are highly economical, when working slowly or even moderately fast, with heavy trains. In these cases in consequence of late cut-off, yet with considerable expansion, and somewhat slow movement of the steam, the losses described are small, and bear a small proportion to the total work done. The result is that the compound is enabled to bring out those valuable qualities undiminished, which in numerous cases it has proven itself to possess.

Most compound locomotives have a low-pressure port ridiculously small, so small, in fact, that, while simple engines require an extravagant velocity of steam through ports, even as high as 1500 ft. per second, some compounds have it two to three times as great. In such locomotives the loss between the cylinders is enormous, and the engine becomes useless for high speeds.

The compensation for the loss between the cylinders, to which reference has been made, is the increase in the area of the low-pressure diagram, produced by the fact that compression should occur only up to the initial pressure in that cylinder. The late exhaust closure fills out the heel of the diagram and may add to its area the amount lost between the diagrams. In my experience the loss between the cylinders at 232 revolutions per minute was only 8 per cent., while in many compounds at this speed it is fully 30 per cent. The above 8 per cent. was exactly made up as just described. In the same case the cards realized 87 per cent. of the theoretical isothermal card having the same ratio of expansion and back pressure, and this was fully as much as a simple engine realized under the same conditions. Such a result is remarkable for a compound engine even in stationary service.

This discussion has brought out the fact that the compound locomotive is subject to losses to which the simple engine is not, and which may render it unfit for fast work. Such defects can, however, be fully overcome by large and easy passages, and the oft-repeated statement that the compound is fit only for freight trains is highly erroneous.

From one point of view compound locomotives can be divided into two classes—viz., the automatic, that starts by allowing live steam to pass to the large cylinder only until the engine has made a half revolution or thereabout; and non-automatic engines, that can be operated at will as simple locomotives as long as desired.

I have always taken the position that the non-automatic engine does not allow the compound system to fully realize its object, and that any locomotive which does not immediately become a compound after making an initial movement is to some extent a failure.

It is held by the advocates of this type that the automatic engine does not start well, and that it cannot pull a sufficiently heavy train over ruling grades. Neither of these features has come within my experience, although that has been with freight trains on a continuous grade of 96 ft. per mile, 12 miles long, and with heavy fast suburban passenger work with 11 stops in 9 miles. It is no exaggeration, in fact, to say that the starting of the automatic engine has been uniformly surer than that of the simple engine in this service.

The point here considered is of the greatest importance in suburban or elevated railway work, for here the compound is particularly economical if it is a compound from the beginning. If it is a simple engine for some little time, the greatest part of its peculiar adaptation to the work which requires frequent starting is lost. This will be referred to again.

From another point of view, compound locomotives are divided into two, three, or four-cylinder engines. Here appears a radical difference in detail, and one that must not be passed over without discussion.

In designing an engine for any kind of work it is fundamental that the smallest cylinders that will properly expand the steam should be used, and that the smallest number of cylinders should be used. By pursuing any other course more cylinder, piston, and piston-rod surface is obtained than is necessary. As cylinder condensation is the greatest of all enemies of economy, by using multiple cylinders we invite our greatest enemy to be always with us. It is at least approximately true that cylinder condensation is proportional to surface, other things being equal, and dealing with common sizes, the cylinder, piston, and piston-rod surfaces of a four-cylinder compound engine will be found to be about 33 per cent. in excess of those of the two-cylinder type. It is evident that the four-cylinder compound is therefore very seriously handicapped, when competing with the two-cylinder compound.

No further logic should be necessary to show that the four-cylinder compound cannot be justified from an economical standpoint, and has no reason for existence except as a means of producing a balanced engine.

If a two-cylinder compound requires a larger low-pressure cylinder than can be accommodated, two low-pressure cylinders can be used in its place, cast together, one above the other, and yet with advantage over the four-cylinder engine.

I now wish to consider the various kinds of railway service with reference to the economy of the compound locomotive. Assuming that the compound is of the automatic type, the order of economy is as follows, the greatest being first:

Elevated city railway service; suburban railway service; freight railway service; express passenger railway service.

The economy on the elevated railway is due to the great amount of starting and acceleration of trains. The simple engine can only do this when working steam at full stroke or late cut-offs, while the compound engine will expand the steam some two and one-quarter times when starting, and much more soon afterward. Bearing in mind the great economy of steam gained by the early stages of expansion, the economy of the compound is evident. The following table shows the relative values of a pound weight of steam at different points of cut-off:

POINT OF CUT-OFF.	VALUE OF 1 LB. IN WEIGHT OF STEAM.
Full stroke	1.000
$\frac{1}{2}$ "	1.659
$\frac{1}{3}$ "	2.000
$\frac{1}{4}$ "	2.207
$\frac{1}{5}$ "	2.343
$\frac{1}{6}$ "	2.435
$\frac{1}{7}$ "	2.495
$\frac{1}{8}$ "	2.532
$\frac{1}{9}$ "	2.552
$\frac{1}{10}$ "	2.560

This table shows that when the simple locomotive starts, it is using steam in such a way that 1 lb. in weight does work of a value of 1, while the compound obtains from the same weight of steam work represented by 1.659 at least. In most cases it will be more than this, say 1.768 for $2\frac{1}{4}$ expansions.

The saving in steam is therefore $\frac{1.768 - 1}{1.768} = 43$ per cent.

Soon after, the simple locomotive is expanding the steam twice and the compound fully four times. The steam quantities are then 1.659 for the simple and for the compound 2.207. The saving in steam is then $\frac{2.207 - 1.659}{2.207} = 25$ per cent. The actual savings made by some compounds in elevated service show that these figures are not far from the truth.

In express passenger service the quantities would be somewhat thus:

$$\frac{2.435 - 2.207}{2.435} = 9 \text{ per cent.}$$

The remainder of the saving in steam would come from the other causes mentioned in this paper, but chiefly from reduced cylinder condensation.

If we add to this effect the economy due to reduced cylinder condensation, and diminished ejection of sparks from the stack, the economy of the compound is still more marked, and it is evident that in elevated service the non-automatic compound loses a great part of these advantages.

Following out this reasoning the order of my list of services will be justified. Unfortunately if the simple locomotive uses the upper grades of expansion, some 40 or 50 per cent. of this steam will be condensed in the cylinders.

The saving of fuel by the compound locomotive is materially affected by its increased evaporation per pound of coal, which amounts to some 15 per cent. Added to this a saving of some 15 per cent. in steam consumption, it appears an easy matter to save 30 per cent. in coal.

In closing, I desire to refer to the claim made by many persons that the saving by compounds is due to larger boilers and higher pressures. There have now been so many trials of engines of both types with boilers and pressures the same, that this view is gradually being abandoned. I have myself conducted trials of simple locomotives with pressures of 140 lbs., 160 lbs., and 175 lbs., and have been unable to perceive any material difference in water consumption. Perhaps the most conclusive trials of this character were carried out by the Caledonian Railway in Great Britain, where the same engines have been tried with pressures varying from 150 lbs. to 200 lbs., over long periods in the same service. I have been informed by the late Locomotive Superintendent of that line, that their conclusion was that the most economical pressure for a simple locomotive is from 150 to 160 lbs.

The grand fact to remember in all of these considerations is that the compound locomotive can use as little as 20 lbs. of steam per hour per I.H.P., while the simple locomotive cannot use less than 27 lbs., and in passenger work such a result for the compound can be attained by avoiding a net loss of work between the cylinders.

DISCUSSION.

Mr. Nichols: I have been very much interested in compound locomotives, and also in what Mr. Dean has said. He speaks of the advantage compound engines have for elevated service. They, of course, appeal directly to the elevated railway; first, from the practical standpoint of a lesser amount of dust and ashes, smoke, steam, etc., emitted, from the fact of using half the number of exhausts, and not only from that, but from the fact that these exhausts are emitted at considerably reduced pressures, certainly not more than one-half that of simple engines. The result is less trouble to people alongside of the road and less noise. It might seem rather strange that the subject had not been more generally taken up, therefore, by elevated railroad people, because of these advantages, in addition to the greater advantage of economy in fuel, which now has been thoroughly demonstrated in favor of the compound engine. Of course, there are many reasons why that has not been done. The same reasons, I suppose, would apply to prevent the adoption of electricity or something that might be better than steam—that is, in other words, the objection that it costs a great deal to make any change; and railroad managers, particularly elevated railroad managers, are specially conservative in making changes of this kind. In 1890, I think, three engines out of 75 were changed from simple to compound. These three had been wrecked. They were originally Rhode Island engines. They were rebuilt by that works then and made compound engines; they have been in continuous service ever since, running side by side with simple engines of the same class and capacity. The cylinders, which had been originally 11 in. in diameter, were made, on the high-pressure side, $11\frac{1}{2}$ in. in diameter, and the area of the low pressure was 2.4 times the area of the high pressure. Those engines had no increase in boiler capacity, no increase in any of the parts, no material increase in the weights. I lay stress on this for what I am coming to later. The experience with these three engines was so satisfactory, for the reasons spoken of—less vexation to the passengers and to residents along the line and decided economy—that it led in 1892 to the construction for new work of 19 other engines, all of them two-cylinder compounds, 16 of them built by the Rhode Island Works and three built by the Pittsburgh Locomotive Works; the Rhode Island locomotive engines being the automatic engines that Mr. Dean has spoken of—that is, changing from simple to compound; and the Pittsburgh engines being of the non-automatic type, requiring to be changed from simple to compound. The old engines weighed 24 or 25 tons. The new engines were made heavier, and weighed 28 to 29 tons. This was done because we were determined to use five-car trains, and wanted to make sure of them on the absurdly heavy grades which, unfortunately, obtain in all cities.

Now as to the result. Some observations of these particular engines, made soon after they were on—I compare now the new compounds with the old simple engines—and on several runs that were made, the average of these I give for the simple engine drawing a four-car train loaded. The starting time —that is, from the time of getting up to full speed—averaged

28 seconds; the time of run between stations at full speed, 44 seconds; the slowing down, 18 seconds, and the standing time at the stations, 11¼ seconds. For the compound in the same service, same weight of train, etc.: Starting time, 28 seconds; full speed, 38 seconds; slowing down, 21 seconds, and the standing at the stations, 11¾ seconds. The standing at the station, simple or compound, had nothing to do with that, because that depended more largely on the facility for passengers getting in or out. The compound reached full speed quicker than the simple. Our anticipation had been, and it had been predicted by opponents of the compound engine, that there must be trouble with compounds in this respect—that they would start more slowly, and that they would come to a stop more slowly than simple engines. But the opposite was proven in these cases. On the other hand, we noticed that the simple engines slowed down in 18 seconds and the compound in 21. That was due largely to the fact that the compound engines were heavier than the simple engines were, and that they used the air brakes only, and had not the Westinghouse brake. I think it is entirely attributable to that—that the engineers would hesitate with a heavy train to slow down for fear of causing disturbance to the passengers. So that the advantage seemed to be on these runs on elevated railroad service just where it was predicted the engine would not succeed. It seemed as though they had succeeded to the fullest anticipation. The time of this run, which was 4.22 miles, was 22.8 minutes for the simple and 20.2 for the compound, or averaging 12 1 miles an hour, including 11 or 12 stops for the simple engine and 12¼ for the compound. This speed was afterward increased. When that run was increased to 6 miles it was determined to speed the engines up more, and an average of 15 miles, including the stops, was maintained with the compound engines, and we never did have a simple engine that would maintain that 15 miles an hour and make the 19 stops in the 6-mile run. That is partly due to the weight—the compound would always do it. The result is substantially this—I make the claim mildly—I know that we are saving 20 per cent.; and some claim—the Rhode Island expert, Mr. Batcheller, now deceased, who designed the engines, claimed, and demonstrated to his satisfaction, and I think to mine, that he was making a saving of nearly 30 per cent. in fuel and in water; but I claim merely 20 per cent., and our average practice will show 20 per cent. saving, or it will show that those engines are annually saving 20 per cent. of the cost of the engines in the use of fuel and water; and that becomes very important, particularly on elevated service, where our fuel and water approximate to 25 per cent. of the total expenses of operation.

There was a great deal of criticism made as to these engines, and there was an unfortunate time in 1893 for the engines, in which year I am a little afraid the four-cylinder type was favored more than these. The effect was that the whole of these 19 engines were laid out of service for upward of six months. It was decided that they were not satisfactory, and that they were giving us a great deal of trouble. The nature of that trouble was this: that there was a disagreeable jolt in starting and stopping those engines, so as to disturb persons in their seats. A great deal of time and attention was given in trying to find out what that was attributable to. I never was fully satisfied in my mind what the trouble was. The fact, however, that these things did occur led to careful observation of it, and I have observed the matter carefully and come to the conclusion briefly that the compound engine requires a great deal more care given to important details. It requires a great deal more care and attention in its repairs, in keeping in order, and probably considerably more expense than the simple engine; that it requires—I speak now of these two-cylinder engines—it requires a great deal more care and skill in running, particularly in elevated railway service. I have seen runners make four and five stops without disturbing a person any more than you would be disturbed in sitting in a chair here, and then on the sixth or seventh stop bring the train up with a jolt that would almost throw you on your head, showing at once, the engine being on the same run, that there must be a great deal of it in the individual runner; and that became so impressed on my mind that, although I hesitated a long while about it, I was almost determined that it was very largely prejudice on the part of the men—that they were determined not to run those engines smoothly. That is a pretty severe accusation to make, I know; but it leads to this general result, from my standpoint: that I would not advise using compound engines in connection with simple ones, or the reverse, you may say, because if men become accustomed to one type of engine it is difficult for them to become reconciled to another type; and the simple engine requires a little less knowledge to understand. The runner does not need to know about the intercepting valve. The result is, he avoids it and does not use his best efforts to make it do its best work. I think a great deal of our trouble with compounds has been due to that. I have never heard or known of a case where the three original compounds—changed over, mark you, from simple into compound, and therefore not specially designed as compounds, and those three compounds are running side by side with the simple engines—I have never known or heard of a case in which those engines ever jarred a train, so I think it almost conclusive proof of what I said.

Mr. Dean's reference to superheating has a significance, to my mind, because a friend of mine, quite a skilful engineer in the city and rather an opponent of compound principles, said that he thought the steam gap in the smoke-box of the two-cylinder engines was quite enough to correspond with about 20 per cent. gain, and was disposed not to ascribe anything further to the compound principle; but he was finally, after discussion, induced to state that he believed that would not amount to more than about 10 per cent., and to acknowledge that there must be something like 10 or 15 per cent. saving in the compound principle itself from other causes.

Mr. Platt: I would like to ask for information, from these gentlemen who are familiar with the compound locomotive, upon this question: Given two roads about the same length but of very different characteristics—for instance, take the Hudson River Road from here to Albany, about 142 or 143 miles, and the Delaware, Lackawanna & Western to Scranton, about the same distance, one being practically level, and the other having a rise of somewhere about 2,000 ft. above tide water, besides the very irregular grade between here and the Summit, the Summit being about 110 miles from here, and then falling 1,200 ft. into the valley—would you expect anything like the same economy on such an undulating road as you would on a road like the Hudson River?

Mr. Dean: I think perhaps I can say something on that subject. I should not expect quite the economy; only, however, from one standpoint, and that is that the engines between here and Scranton would have to run down hill considerably, and they would be burning coal while running down hill, and therefore they would not have the opportunity to be saving during that time. But, on the other hand, while they were climbing the hills they would be saving more than they would if the road was like the Hudson River; so that possibly they might come to be saving fully as much, and I rather think more than they would on a level road, because the compound produces marked saving in climbing hills. But on the Lehigh Valley Railroad, where an engine of my design is running up the 96-ft. grade out of Wilkesbarre, the service is peculiar and the saving cannot be as great as is found in many other places, for the reason that the engine pushes a train of coal cars up to the top of the grade and then comes down empty; then turns around and pushes another train up the grade, so that in 24 hours, even by working pretty late in the evening, they can go up that hill three times—and it takes about an hour to go up—and they would be saving coal during three hours—it is anthracite coal—and burning it during the rest of the 24. In the actual case where this engine was tested against the best simple engine they had—of course that is always the case; where there is one compound it is always put against the best simple engine—the actual saving in coal was a little over 16 per cent. and in water over 13 per cent. But where the engine was taken down on another division which was nearly level the saving in water was 25 per cent.

Mr. Vauclain: I think, Mr. President, that the economy that we could expect from the compound locomotives operating under those conditions would depend almost entirely on the manner the locomotives would be loaded. If the engines were running at the same point of cut-off in both cases, we would expect the same economy from the engine so long as it was under speed. If the engine were loaded to its most economical point of cut-off on the level, and was using steam constantly from one end of the road to another, we would certainly obtain a much better result on a level road. On a hilly road we would have to load our engine so as to be able to haul the train on a maximum grade. Therefore on certain portions of the road the engine would be operated at slight disadvantages—that is, there would not be the same economy as if the road were uniform. In addition to that, the drifting of the locomotive would be simply permitting that engine to waste fuel in order to maintain the pressure, so that the steam would be available when they wanted to make use of the engine.

The locomotives upon the Pike's Peak Railroad were first constructed as single-expansion engines. The road is about 9 miles long. The maximum grade is 25 per cent. The minimum grade is about 7 per cent. The engines did fairly good work. They were very well satisfied with them. But the consumption of water was enormous, and also the consumption of coal, necessitating several stops for water and fuel, and prolonging the duration of the trip, so that the runs were not very

profitable. The business of the road, however, increased to such an extent that it became necessary to have another locomotive; and as I had taken the trouble to go there and set the single expansions up, they consulted with me as to what I thought would be the best type of engine to buy—whether I would advise the use of compound locomotives. I said I certainly would, and that we would guarantee that the performance of the compound engines would be superior to that of the single-expansion engines. Under those conditions we built them a compound locomotive of the same capacity as the single-expansion engine, and the economy in fuel was about 35 per cent.—from 35 to 38 per cent. The consumption of water was about 25 per cent.—between 25 and 28 per cent.—necessitating one less stop for water and one less stop for fuel. The speed of the machine going up the hill was also increased. We reduced the time from about two and one-half hours with the single-expansion to one hour and 50 minutes with the compound engine. This performance was so satisfactory to this road that after one year's use of the compound engine they negotiated with us and arranged to have the three single-expansion engines returned to the works and converted into compound engines, and now the road is operated exclusively by compound locomotives, and they would have nothing else.

There is still another point in connection with these locomotives on the Pike's Peak Road. It is a very easy matter to get up to the top of the mountain; but after you are up there it is not such an easy matter to come down again. You cannot use ordinary power brakes and come down a 25-per cent. grade. It is simply like sliding down an ordinary cellar door. The manner in which we get down hill is to convert the cylinders into air brakes. We use them as an air brake, or what is ordinarily termed a water brake. We lead a jet of water into the exhaust passages of the cylinders and throw the engine in forward motion, and let it drift backward down the hill. We have the exhaust passages piped up and a regulating valve on the pipes, so that we can reduce the air pressure in the cylinders and steam-pipe passages to any desired pressure that we see fit, and we find that this system of braking is very much more effective on a compound engine than what it is on a single-expansion. The engineers have very much greater control over their trains than they formerly had with the single-expansion engines. The locomotives are four-cylinder compounds.

Mr. Platt: I would like to ask Mr. Vauclain, when he gets up again, to explain the difference between the operation of those engines coming down the hill and the ones on the Rigi Road. I noticed a very different sound coming down the Rigi from coming down Pike's Peak. My recollection is that in the Rigi there is just as much of an exhaust coming down the hill as going up, one being exhausted with compressed air, the other being exhausted with steam; but that there was no exhaust at all on the Pike's Peak Road. I was out there in October, but I have not been on the Rigi since 1881, and I would not undertake to say that those engines are there now.

Mr. Vauclain: I think that the noise in the Rigi engines is perhaps due to letting go of the compressed air in the smoke-box. With the ordinary locomotive, when you are running along, if you reverse the lever the engine will take in air and throw it out again in the smoke-box, causing a noise similar to that of exhaust steam; whereas on our system of water brake we pipe the exhaust back to the cab of the engine; we put a regulating valve on there with a muffler. We lead the air out under the cab at the back end of the engine where it is unnoticeable If any one sees fit to ride on the locomotive, he can hear this air escaping out of the muffler very quietly. They are somewhat similar to the mufflers used on the elevated locomotives here with their Eames vacuum brake. But when it is thrown out into the smoke-box it makes a noise similar to the exhaust. We found it more satisfactory to seal the exhaust, so we have a valve which fits into the exhaust port; when the exhaust is closed to the smoke box it is open to the atmosphere underneath, so that nothing but good clean air can be taken in.

When I received the invitation from the committee to come here and speak for five minutes on compound locomotives, it was with considerable hesitation that I made up my mind to come. Being the patentee of one of the most extensively used systems of compound locomotives in this country, I have a slight hesitation in speaking about them before an association of this kind; I might be accused of taking advantage of the opportunity to advertise my wares. I naturally am favorable to the four cylinder compound. I do not wish you to understand that I take the position that two-cylinder compounds are no good. I believe that a great deal of the trouble that we have experienced with the two-cylinder compounds in locomotives in this country and abroad has been due somewhat to the faulty designing and not sufficient engineering skill having been spent upon the designs when the engines were worked out. In this country locomotive builders are apt to take an order for a locomotive and build it very rapidly. It is impossible to build satisfactory compounds upon a basis of that kind unless you have gone through the experimental period and understand exactly what you are doing and know just what to use and where to use it. The Baldwin Locomotive Works, of which I am General Superintendent, have built over 500 four-cylinder compounds. We have built two two-cylinder compounds. When we first introduced this system of engine, the particular style of valves that we used was very much cried down, and it was said that it would prove a total failure and would interfere very much with what few chances the engine had of being a successful compound locomotive. It is this one point—the piston valve—upon which I cannot agree with Mr. Dean. We do not believe that there is any loss in using the piston valve due to the numerous apertures through which the steam has to pass, and the restrictions placed on the free passage of the steam by the bridges in the steam-chest, because by using the piston valve we are able to get a very much greater length of port with very little valve friction than we can with the ordinary slide valve. We are also able to operate steam pressures that it is utterly impossible to operate with the ordinary slide valve.

I cannot permit myself to speak of the numerous two-cylinder compound locomotives that have been changed over to single-expansion engines; but in defence of the piston valve, I must necessarily speak of one, and that is on the Northeastern of England. Mr. T. W. Worsdell was one of the greatest advocates of two-cylinder compound locomotives, and he built a great number for that line—he has now been replaced by his brother. That railroad has found it necessary to change those engines to single-expansion engines. These very two-cylinder compound locomotives are now being fitted with single-expansion cylinders, and those single-expansion cylinders are being fitted with piston-valves, and indicator diagrams taken from those locomotives are far superior to any indicator diagrams I have seen taken from single-expansion locomotives with slide-valves. If the length of port is sufficient, if the passage is free so as to reduce the friction of the steam in passing from one cylinder to the other to a minimum, it seems to me it matters not whether you use a circular valve or a flat valve; and if by the use of a circular valve you reduce your friction to a minimum, much less than what you have in a flat valve, then, it seems to me, it is desirable to use the piston-valve; and in a great many cases the piston-valve can be used where it is utterly impossible to attach a slide-valve.

One reason why we went into this system of compounding was that we had inquired thoroughly into the two-cylinder system. The four-cylinder system is used on the Paris, Lyons & Mediterranean Road in France, and splendid engines those are, but very complicated. I was also in communication with Mr. Sigmund Cadena, now deceased, who was the Chief Superintendent of the Hungarian State Railway Engine Works in Buda-Pesth, and he assured me that he had failed utterly to adapt the two-cylinder compound to high speed passenger service, and had to resort to the four-cylinder compounds for the purpose, and found them very satisfactory. But for us to attempt to build an American engine, making it a four-cylinder compound with tandem cylinders, or inside cylinders with crank axles, or anything of that sort, would not have done at all; we would not have been able to find a market for wares of that kind. The idea occurred to me that by placing the cylinders adjacent to each other—one immediately above the other—and connecting the two pistons to a common cross-head, supplying steam to both cylinders by a single piston-valve, we could get very good results. If we would have losses in some directions we would more than compensate for them by economies made in other directions. There would be no alteration to the locomotives, except to the cylinders outside of the frames and the guide and cross-heads. The internal arrangements, the smoke-box, the links and everything of that sort, would be exactly the same as on the single-expansion engines. Another valuable feature would be that it would be as well adapted to the very heavy decapod locomotive engines, weighing 200,000 lbs., equivalent to a 24-in. × 28-in. single-expansion engine, as it would be to an ordinary wharf rat used for street-car service. It would also do for heavy freight service, and answer for the very highest passenger service that we care to engage in in this country. It is this engine that has practically brought forth the very highest rates of passenger speed that we have had in this country. The Philadelphia & Reading Railroad are using the four-cylinder compound exclusively for their fast Blue Line trains between Philadelphia and Jersey City. The Central Railroad of New Jersey are using the four-cylinder compounds for the same work; and fearing that perhaps the efficiency of these engines was due

somewhat to the design of the boiler and other details, and not to the compound cylinders, other engines of the same type exactly, excepting that the single-expansion engine was given the advantage of 2 in. larger boiler, were built and placed in the same service; but they had no business with them; the compound engines are hauling the trains, the single-expansion engines are doing other work.

I might go on and give you numerous illustrations of this kind. We have over 500 of these locomotives in service. We have made numerous tests. The economy ranges all the way from 10 per cent. up to 43 per cent. When you say 43 per cent., it seems like a very high economy; but it is due entirely to the anxiety on the part of the railway master mechanic to outdo the compound with his single-expansion engine. In this case that I speak of, where there was 43 per cent. economy, it was on a grade 12 miles long, 100 ft. to the mile, with very heavy curves. The engines were loaded to their utmost capacity; the compound locomotive, working full stroke, worked very economically, whereas the single-expansion engine worked at a very great disadvantage and not at all economically. I might add right here that in most of the two-cylinder compounds the ratio of expansion between the two cylinders is from 2 to 2.5, very seldom getting beyond that. I believe the Pennsylvania has one compound that is a little higher—probably about 2.65 or 2.70. We aim at a ratio of 2.8 to 3. We prefer 1 to 3—rather 1 to 2.7—2.85, 2.90, and up to 3 most all of our compound engines average, which gives us a very economical expansion of the steam. We also find the engines very well adapted to elevated railroad service. In Chicago, the South Side Rapid Transit Company, which runs a gilt-edge high-speed service, has 45 of these compound locomotives in service and one single-expansion engine. The single-expansion engine was first made a two cylinder compound in order to compete with the four-cylinder. As we are builders of locomotives, and there being no monetary return to me whatever for my system of compounds, we aim to get the very best, whether it is a four-cylinder or two cylinder compound, or three-cylinder compound or a single-expansion engine. We are in the locomotive business and not in the compound business. But the trials of these engines on the Chicago South Side caused the company to have the two-cylinder engine changed to a single-expansion, when it could not compete as a two-cylinder, and finally is used for switching service in the yard and not run in regular train service.

In coming over this evening from Philadelphia, I happened to ride behind a four-cylinder compound. We were a little late leaving Philadelphia. I timed the train mile after mile in 48 seconds to the mile with five vestibuled cars. It takes an extremely good engine to do that, especially with a small fire-box burning anthracite coal. We have made exhaustive tests of what is commonly known as the Wooten fire box fitted with compound cylinders against the same engine fitted with single-expansion cylinders, and effected an economy of about 24 per cent. Another feature came out in these trials, and that was that the compound engine could burn a very much inferior grade of fuel, and the contrast was so great that now the Blue Line trains between New York and Philadelphia are using nothing but what is called buckwheat coal, which costs the company about 35 cents a ton, whereas before they used the best quality of egg coal for the work. The Philadelphia & Reading operates 78 compound locomotives.

The lowest water rate per I.H.P. that we have taken off has been at very slow speeds—say from 60 to 80 revolutions per minute in freight service on the New York, Lake Erie & Western Road, and those engines run as low as 17½ lbs. of water per I.H.P. per hour. That result was obtained, of course, by being able to get a very fine indicator diagram on account of speed. There was very little loss between the two cylinders, and the back pressure in the low-pressure cylinder was very slight. We have also noted in these trials that the most economical point of cut-off that we could find in a single-expansion engine was about one-quarter stroke, and that was about 27 lbs. of water per I.H.P. When we cut off at half stroke the water-rate had very much increased, due to condensation and less expansion, and at the three-quarter stroke it was very much more so. At shorter cut-offs the increase in water rates was very much more rapidly than when working beyond one-quarter stroke. In the compound engine we found a variation of about 2 lbs. in the water-rate between three-eighths and three-quarter cut-off; so that the indicator diagram has proved what we found in the tests, that the compound had a greater range of economy—that is, it could be worked at various points of cut-off and still be a very economical working engine; whereas the single-expansion engines could only be worked economically at one-quarter cut-off, and when you departed from that you would have made up your mind to waste coal in order to get increased efficiency out of your locomotive.

I have this to say: We have made numerous tests of these engines. We have the tests in printed form, and any one who takes a sufficient interest in the matter of compound engines, and would address me at Philadelphia, I would be very glad to mail him all the literature that we have on the subject, and he could read it at his leisure and digest it.

At this point, Professor Hutton read the following communication on

TWO-CYLINDER COMPOUND LOCOMOTIVES IN FREIGHT SERVICE.

BY C. H. QUEREAU.

Road Test with Dynamometer Car.—The following gives the principal results of careful road tests of two simple and two compound locomotives, made in freight service, with a dynamometer car, water metres, etc., in accordance with the code adopted by this society, except that the steam calorimetres used were found defective in construction and the results obtained from them were not used. For reasons which in no way affect the accuracy or reliability of the results, the names of the railroads owning the locomotives are not given. The averaged results of the tests will be found in Table I. The compounds were of the two-cylinder type, with a receiver in the smoke arch. A trip consisted of a run of 117 miles with 28 loaded freight cars, a different train being taken each trip. There were several 1 per cent. grades each way. The same engine crew handled all the engines, and the same testing crew of four persons took the records. All springs, gauges, and water metres were calibrated, coal from the same mine was used on all the engines, and great pains taken to have all conditions as nearly uniform as possible. Table A gives the principal engine dimensions.

TABLE I.

AVERAGED RESULTS.

Engine Number.	No. of Trips.	Dyn. H.P. Hrs. per Trip.	Water per Dyn. H. P. Hour.		Speed, Miles per Hour.	Steam Pressure.
			Lbs.	Per cent.		
1 Compound..	5	2,105	33 7	102.4	20.6	171
2 "	6	1,906	32.9	100.0	23.2	170
3 Simple ...	4	1,918	38 6	117.3	19.4	171
4 "	5	1,922	38.5	117.3	18.4	179

TABLE A.

ENGINE DIMENSIONS.

Engine...........	Number 1.	Number 2.	Number 3.	Number 4.
Type...............	2-Cyl. Comp 10-wheeler.	2-Cyl. Comp Mogul.	Simple. Mogul.	Simple. Consol.
Mean running weight, lbs.......	200,000	172,000	182,000	175,350
Weight on drivers..	118,000	98,000	106,500	101,800
Diameter of drivers over all	56"	62"	62"	49"
Cylinders, in........	19 & 30 × 24	20 & 29 × 24	19 × 24	20 × 24
Valve travel.........	5½"	6"	5"	5½"
Valve...............	Plain bal.	Plain bal.	Allan bal.	Plain bal.
Exhaust nozzle, diameter........	5"	4⅞"	5"	5"
Diameter of boiler..	58"	56	60"	60"
Grate area, sq. ft...	31.3	31.5	31.5	34.7
Heating surface, sq. ft..........				
Tubes.............	1,756	1,380	1,555	1,391
Fire-box............	172	126	136	164
Total............	1,928	1,506	1.691	1,555
Miles on flues	8,000*	7,318	5,941	42,231
Miles on fire-box...	8,000*	133,322	56,526	150,353
Pops released at....	185 lbs.	185 lbs.	185 lbs.	185 lbs.

Because of the great differences in the distribution of the heating surfaces, and differences in their condition due to scale accumulated during varying periods of service, as shown in Table A, the evaporative efficiencies of the boilers and the coal used by the different engines are not comparable, and are not shown in Table I. It, however, shows that the conditions as to work done, speed, and steam pressures, were reasonably uniform for the several engines; that the compounds were more economical than the simple engines in the use of steam by 15 per cent.; that this saving was not due to the use of higher pressures for the compounds, and should therefore be attributed to the compound principle.

The figures given in Table I. for water used per unit of power developed are based on the assumption that all the water was used in hauling the cars. In Table II. is given the water used per unit of power developed in hauling the total load, which includes the engine as well as cars, based on the weights of the engines and cars. As the weights of the cars and their contents were taken from the stenciled weights on the cars and the bills of lading, Table II. should be considered as only a close approximation.

* Estimated.

TABLE II.

Engine Number.	Water per Dynamometer H.P. Hour.	
	Lbs.	Per cent.
1 Compound	30.0	101.4
2 "	29.6	100.0
3 Simple	34.7	117.2
4 "	35.2	118 2

From the dynamometer records the average pull for each engine for all its trips was found, and indicator cards from each engine were selected which showed on the dynamometer record practically the same pull as the average. The average indicated water per I.H.P. hour was then calculated for each engine from these cards. The results are given in Table III.

TABLE III.

Engine Number.	Average Pull of Engine.	Pull for Card.	Indicated Water.	
1 Compound	8,340	8,600	16.92	17.20
2 "	7,520	7,500	17.50	
3 Simple	7,350	7,500	18.80	18.90
4 "	7,000	6,900	19.00	

Inasmuch as the indicated water is a fair basis on which to compare the efficiency of engines in expanding the steam used, it follows from Table III. that the steam was expanded by the compounds 9 per cent. more economically than by the simple engines. Table 2 shows that the compounds used steam 15 per cent. more economically than the simple engines. It would seem just to believe that the difference between 9 per cent., the saving of the compounds due to better expansion, and 15 per cent., the total steam economy of the compounds, was due to a saving because of less cylinder condensation. That the effect of the receiver in the smoke arch was beneficial in reducing condensation there can be little doubt, but tests of compound engine 2 have shown that there was no superheating of the steam as it passed through the receiver. It seems reasonable to assume that, had the boilers of the compound and simple engines been the same, the economy of the compounds in coal would have been at least as great as their economy in the use of steam.

Records Made in Service.—In Table IV. are given results obtained from records made by compound and simple locomotives in regular freight service obtained from the roads owning the engines. In each case the compound and simple engines compared were identical except in modifications of cylinders and valve-gear made necessary by compounding; they were also operated on the same divisions and in the same service. The Chicago, Burlington & Quincy engines were run in the same pool, each engine crew taking each engine in turn.

TABLE IV.

Railroad	C., C., C. & St. L.		C., B. & Q.		C. & O.	
Period covered by records	9 months		1 month		1 year.	
	Comp.	Simple.	Comp.	Simple.	Comp.	Simple.
Engines in service	1	12	1	40	1	10
Steam pressure, lbs.	180	180	180	160–180	155	150
Aver. train, loaded cars.	24.7	24.3	31.6	25.1	35 1	36.1
Lbs. coal per car mile	3.7	4.8	3.27	4.6	3.7	4.9
Best simple coal record.		4.2		3.85		4.4
Repairs per 100 miles	$3.90	$4.09	*		$1.61	$2.27

As in Table 1, the simple and compound engines used practically the same boiler pressure, and the difference in economy is due to the compound principle. Table IV. shows a saving in fuel for the compounds as follows:

	C., C., C. & St. L.	C., B. & Q.	C. & O.
Over average of all simple engines.	23%	29%	25%
Over best simple engine record	12%	15%	16%

The Cleveland, Cincinnati, Chicago & St. Louis compound has been in service about two years; the Chicago, Burlington & Quincy compound about four years; and the Chesapeake & Ohio compound about two and one-half years.

Table IV. further shows that the compounds hauled as heavy trains as the simple engines.

Conclusions.—The writer would draw the following conclusions:

1. There are compounds in service which are more economical in the use of coal and water than simple engines of the same dimensions and doing the same work in freight service.

2. The minimum economy of the compounds is not far from 15 per cent. It is probable that about two-thirds of this economy is due to a better expansion of the steam, and about one-third to less loss by condensation.

3. The compounds have been in service too short a time to warrant final conclusions as to their cost for repairs, but the experience to date and theoretical considerations strongly indicate that this item will be no larger for the compounds than for the simple locomotives of the same dimensions and doing the same work.

* Because of several changes in valve gear, and a wreck, charged to repairs, it would be very difficult to determine the cost of repairs for the C., B. & Q. compound. It is the opinion of those having the engine in charge that her repairs cost no more than for the simple engines, if as much.

Mr. Ball: Mr. Vauclain has told us about the advantage in the piston-valve in the way of large port openings and saving in the friction in the valve; but I do not remember that he said anything in regard to the question of possible leakage. I do not know whether they have had any trouble of this kind in the locomotive or not.

Mr. Vauclain: In casting the cylinder it would not be a wise thing to cast the bridges and everything in the ports in the cylinder casting. We therefore allow the ports to terminate in this cylinder, and fit a cast-iron bushing in, carrying the ports, and bridge them over. We do that on account of the valves. The valve is fitted with packing rings just the same as an ordinary piston, and these packing rings take the wear. We were afraid that we would have trouble with these valves; but having had several years' experience with Westinghouse stationary engines, both compound and single expansion, we were brave enough to start out and put piston-valves in locomotives. We have never had a bit of bother with steam engines running with packings of that type. The rings are ordinary cast-iron rings sprung into position, so that when they feel the push they come together within one-sixty-fourth of an inch. The bottom of the casting has a wide bridge on which the ring abuts in the centre, so that as the ring wears it gradually moves around a trifle. We were afraid that these bridges would wear the rings in grooves, and the rings did wear in grooves in some cases. We found that where they did so wear it was on engines that were used in drifting down heavy grades and not permitted to run at full stroke or run partially in the cut-off, the reversing lever pushed out slightly, which caused them to suck in dirt and cut out the rings of the low-pressure valve. By putting larger relief valves on this engine and keeping the sparks from being drawn into the valve chest we entirely did away with that cutting.

A few days ago I was on the Norfolk & Western Railroad, and asked Mr. Soule how soon he thought that he would have to renew some of his bushings. He has some large engines there that we built three years ago, and since that time we have concluded to enlarge the valves 1 in. on that size of engine. I advised him to rebore the cylinder and put in a larger bush. He remarked that he would when these bushings gave him trouble; that he was very much disappointed; that he had looked for a great deal of trouble with these piston-valves, and that they had given him less trouble than the slide-valves.

The President: You spoke of being able to use higher boiler pressure with the piston-valves than without. What is the highest pressure you have used?

Mr. Vauclain: Two hundred and twenty pounds is the highest pressure we have used. This point was brought out on the Chicago, Milwaukee & St. Paul Road in this country, and in England it was found that at 170 lbs. they had reached the limit for slide-valve service; but after they got beyond 175 lbs. they had trouble with the valve getting dry and cutting. On the Chicago, Milwaukee & St. Paul we built them some engines 180 lbs. pressure single expansion, and also one compound; the compound showed an average fuel economy for the entire year of about 17 per cent. running against those engines. Mr. Barr, who is very glad to find out if there is any economy in an engine, whether it is compound or single expansion, thought that perhaps by running his single-expansion engines at 200 lbs. pressure he would get just as good results as with the compound. The compound was running at 200 lbs. They increased the pressure on the compound from 180 lbs. to 200 lbs. on account of the diameter of the cylinders being slightly under what the cylinder power was on the single-expansion engine, and as the boiler had been built for 200 lbs. on both classes, they screwed down the safety-valves and let the single expansion run at 180 lbs. and the compound at 200 lbs. When the single expansion was put up to 200 lbs., they found no end of trouble; their valves got dry, and after several months' experimenting, I think that Mr. Barr succeeded in balancing the valve, or getting it so that it gave him very good satisfaction—at least he thought so; but other things came into play. He found that there was a loss of economy by increasing the single-expansion engine to 200 lbs., and they put it back to 180 lbs.

We have run 235 miles with a pint of cylinder oil, in high-speed passenger service, burning the very worst kind of fuel, which is bituminous coke. The grit and dirt from coke, if drawn into the cylinders, cut them like emery. We built an engine for the World's Fair, called the *Columbia*, with 7-ft. driving-wheels, of decidedly new type for this country. The Philadelphia & Reading are the only road using them. They have a two-wheel pony truck in front. The driving-wheels are in the centre of the engine, and a trailing-wheel back. This engine ran from Washington to Jersey City on one tender load of coal and one pint of lubricating oil, and there was still some lubricating oil left in the lubricator when we got there.

The President: I think, Mr. Vauclain, if you will excuse me for saying so, that your comparison of the 200 lbs. pressure of the simple engine compared with the compound is liable to be misleading, because in the compound engine you have the pressure divided half and half between the two cylinders, while the low-pressure cylinder would not have more than the receiver pressure on the back of its valve on the other side; and although there is 220 lbs. on the top of the valve, there would be about half of that under the valve in the receiver, so that the difference would be considerably less than in an ordinary simple engine. So I rather fail to see why a compound engine could not carry 220 lbs. with a slide-valve as well as the simple engine could carry 150 or 160 lbs.

I think it no more than right to explain that, although I am in the chair, I may have had experience in the matter that may be of benefit to the fraternity at large that might not come in in any other way. I happen to know of, and have been interested personally in, the testing of a compound engine recently which carried 220 lbs. of steam with the ordinary slide-valves balanced in the usual way. Part of the time they had the American balance and part of the time the Richardson balance. The ports were 23 in. long; and that engine carried for one month, under very severe service, 220 lbs. boiler pressure, and for the remainder of the time, 200 lbs. But I made a particular point of examining the valves to see if the faces stood the wear well—and they did. There was no appreciable cutting of the faces at all, and it was concluded that that pressure was not excessive for that type of valve in that case. I only mention that as a piece of information that ought to go side by side with the statements of Mr. Barr's experience with the other engine.

Mr. Durfee: I would like to make some inquiry as to whether any of the bars dividing the ports on compound or other engines using piston-valves have been made inclined to the axes of the cylinders. Some years ago, on the Edinburgh & Glasgow Railway, there were some very large engines built with piston-valves, and the ports of those engines were that way—the bars dividing the ports were placed at an angle, so that they did not have any effect of grooving the piston-valves. I do not know that that construction is in use at all at the present time.

Mr. Vauclain: We have made probably a hundred bushings of that sort; and we think that it is simply a matter of choice. The angular bridge may wear the ring much better than the straight bridge. But the straight bridge gives sufficient satisfaction, and is very much more easily made, and you are less liable to break the bushing forcing it in with a straight bridge than with an angular bridge. It is for that reason that we adhere to the straight bridge. But for any one desiring such a bridge, we are happy to put in the angular bridge and bushing.

Mr. Dean: I have had something over three and one-half years' experience now with the compound locomotive carrying no less than 180 lbs. of steam, and a good deal of the time carrying 195 lbs. While the engine had been in service three and one-half years, the slide-valves had never been taken out of the chests, and there was no reason for doing it. Recently, however, Mr. Henney, who succeeded Mr. Lauder on the Old Colony system, desiring to ascertain independently the relative merits of the compound engine and the simple one, has had the compound engine taken into the shop, and also the simple engine, and both engines are being put into the very best possible condition. Whether it was known that anything was wrong or not, no chances were taken; so that the valves were taken out of the chests with the idea of facing off the valve seats and valves of the compound engine. When they were taken out after three years of service, the foreman of the shop was quite undecided whether it was best to face off those valve seats or not. But I finally told him that we had better have everything as good as we could have it, because this was a very important test—it was to convince a sceptic. The valves and the valve seats were simply admirable after this long term of service. Not only is this the fact, but in running the engine the engineer can take hold of the lever with his left hand and move it when steam is on just as easily as not. There is very substantial evidence that a slide-valve with the Richardson balance is perfectly satisfactory in pressures above 180 lbs.

Mr. Bishop: The greatest trouble we have had with the Webb compound is being unable to start the low-pressure cylinder of the front pair of wheels. The valve motion was run with the link motion and two eccentrics, and that was afterward changed to a loose eccentric, with a step for forward and back motion; so of course the engine would have to be started before the eccentric would come to a start governing either motion. So in backing up to the train the eccentric was set for the back motion, and unless you started the train the back wheels would go forward and the forward pair of wheels would go backward, and of course it was impossible to make any progress; and if the low-pressure wheels happened to get on the centre, the receiver would fill up and no progress would be made in any direction, so that it was found to be almost impossible to use it on any of our trains, and it has been out of service most of the while. I think that the valve motion on that engine was in very bad shape. I saw some indicator cards from the engine which showed excessive back pressure in the high-pressure cylinders, and that the valves were not square; so that perhaps that would account for not being able to get a speed of much over 60 miles per hour out of the engine; the engine was very rough riding and had a very jerky motion.

Mr. Forney: I have listened to the discussion this evening with a great deal of interest; but it has been all one-sided, and I think there are some things that might be said with reference to the question that have not been said. Of course, for any one to come to a meeting of mechanical engineers with the statement that you cannot save fuel with a compound locomotive would be to talk nonsense. But there is a decided difference between saving fuel and in saving money in locomotive service. I have no doubt, either, that in certain kinds of service the economies which have been reported here this evening can be gained with the compound locomotive; but that is a very different question from the economies which can be gained in the average service which must be performed on railroads. I remember, not a great while ago, seeing the report of the performance of a compound locomotive, setting forth the advantages which were gained and the saving in the fuel. On investigation it was found that that locomotive was used on a heavy mountain grade where there was a continuous hard pull, and on which it would have been necessary to work a simple engine at full stroke all the way up to get the best results. Of course under such circumstances the compound showed an enormous saving of fuel. But the railroads of the country generally are not composed of continuous up-hill grades, so that if that engine had been running over the whole length of the line of road on which this test had been made, the saving would have been very different from that which was shown. I also saw a report of one or two compound locomotives in which there is a comparison made of the average performance of 10 engines on two different roads. Now, on making a comparison with the simple engines it was found that the difference between the performance of the best simple engine and the worst simple engine in those 10 was considerably greater than the difference in the performance of the compound and the average of the simple engines. In other words, it makes a very great difference whether you compare a good compound engine with the performance of a poor simple engine. I think in a great many of the tests which have been made thus far with compound engines, they have had counsel for its side. They have had friends who were interested in producing the very best results for the compound engine in the test. But the simple engine has gone into the test without such friends. Some time ago a test was made by Mr. Webb, of the London & Northwestern Railroad, with one of his compounds of the *Greater Britain* type. The report of the performance of that engine, the figures of which I have not with me and do not remember, were the most remarkable that had ever been shown up to that time. About a year ago Mr. Buchanan, of the Hudson River Railroad, made a test of one of his engines of the celebrated No. 999 class, and in that test he produced somewhat better results than Mr. Webb produced with his compound. In that case Mr. Buchanan was interested in producing the very best results with his simple engine, whereas, if Mr. Webb's engine had been tested with some other simple engine and under circumstances where no one was interested in producing the best results, the case might have been very different. At the last meeting of the Master Mechanics' Association, during the discussion of the relative merits of simple and compound engines, a member got up on the floor and stated that it was a most remarkable thing that you could get no one to come on the floor of the Association and say anything which seemed to be derogatory to the com-

pound engine; but if you went out on the veranda of the hotel and sat down in private conversation with the members, he found a great many bitter enemies of the compound system. If you will go around the country you will find there is an immense difference of opinion among people best able to form an opinion with reference to the question of the relative economy of the two classes of engine. I was in correspondence a short time ago with a gentleman who has abundant opportunity of getting information, who is on the continent of Europe, and he wrote me that exactly the same condition of things existed there; that the locomotive superintendents of European railroads were very much divided, and that it was difficult to say on which side the preponderance of sentiment lay. The fact which was related here this evening, that on the London & Northeastern they were changing some of the compound engines into simple engines, is also significant. My mind is still undecided in reference to this question. I think the probabilities are that for certain kinds of service the compound engine will be found ultimately to be the most economical engine, but for much of the service of railroads I think it is still questionable. There was a good deal said this evening by Mr. Nichols with reference to the economy of compound locomotives on elevated railroads. Now, if all the advantages stated here this evening are true, if there are no drawbacks to those advantages, it seems to me that the managers of the elevated railroads of New York must be a blooming set of idiots (*laughter*) not to adopt compound engines as early as possible. It was also said here this evening by the same gentleman that compound engines must be kept in a better state of repair than simple engines; they must be run more carefully than simple engines. Another gentleman said that in order to pull the maximum train on a heavy grade it was necessary to work compound engines simple. Those are very important facts. If you are obliged to keep a compound engine in better repair than a simple engine, that militates against the compound system. If you are obliged to have a superior class of men to run the compound engines, and if your compound engines will not pull your train at the point of maximum grade in going up a hill, those are serious questions. There is also this fact: Compound engines certainly do cost more than simple engines. It is not an easy matter to ascertain precisely what that difference of cost is. It is also another fact that a compound engine weighs considerably more than a simple engine. Now, if I were called upon to design a simple engine to run in competition with a compound, I should be very careful to take that excess of weight which now goes into the cylinders and steam-pipes and valves and various fittings and put it into the boiler, so as to have it larger, and in that way increase the economy in the boiler itself. Now, the fact that the compound system implies more weight is to that extent a disadvantage of the compound system, and I think that if these things are taken into consideration we would be obliged to hold our opinion somewhat in suspense for the present before we come to any sweeping conclusions. As I said before, I believe that for certain kinds of service the compound locomotives would be found to be the most economical and the most efficient; but I believe that thus far we ought to bring in a Scotch verdict of "it has not been proven."

The President: In what I have to say I am entirely disinterested. I am not connected in any way at present, nor likely to be, with any concern building compound engines or locomotives. What I will state will be simply from my experience as an engineer at a time when I did have to do with compound engines. Mr. Forney's criticism as to the increased weight of the compound engine refers simply to the difference of weight in cylinders which puts a little more weight on the front truck. But the difference of weight he finds is really in the boiler. The compound engine can utilize a boiler of higher power to more advantage than the simple engine, for which reason it is perfectly fair to give the compound engines the higher boiler power. That puts more weight on the wheels. In the compound engine of what I think I may be excused for saying is the latest type, there is always reserved the possibility of throwing that engine into a simple engine whenever the service requires it—that is, to turn the engine into a simple engine and get about 25 per cent. more power to cover emergencies. In that way the weight of the train can be increased when there is a number of points where the grade is so heavy that it would limit the average train, and the engine would be pulling under its proper load. That limits a simple engine; and it is perfectly legitimate that the compound engine should take advantage of its capabilities of being able to overcome that by a sudden burst of power. While that, of course, would use a little more steam than the compound engine would use for the time being, it enables the engine to carry a higher average amount of tonnage, and the slight waste of steam is more than overcome by the increased tonnage for the rest of the trip. That is one of the advantages that legitimately belong to the compound engine of the type that has taken advantage of all the possibilities that lie within the limit of the compound system. In regard to the prejudice in favor of the compound engine, I think if Mr. Forney had ridden on as many engines as some of us have who have been trying to introduce compound engines, he would find that the prejudice is exactly the other way—that the compound engine has no friends except the man in charge from the works, whereas the simple engine has friends on every one of the railroads. Whatever advantage the compound engine shows is in spite of the greatest amount of opposition that an engine could possibly have. But the object of these meetings ought to be to bring out both sides of such questions, and I believe it can be truthfully said that this has been the case to-night. There has been no effort on anybody's part to make out the compound engine to be any better than it really is. The tests given have given both sides. The conditions have been as nearly similar as they could possibly be made in testing the two types, and I think it is a remarkable fact that any one could state at this day that prejudice is in favor of the compound engine, because the compound engine is a new thing, and, as Mr. Nichols said, is being introduced against the conservative ideas of the powers that be. So that when a compound engine comes on a road it has to labor against all the disadvantages that Mr. Forney seems to think the simple engine has. In spite of that, we find that the compound engine to-day is gaining ground instead of losing it. Of course the original types of compound engines were very faulty. I think you will find that every improvement in machinery has been gradual, and mistakes have been made; but if you will take some of the later engines, where people have availed themselves of the experience of those who have gone before, you will find that those engines have been unqualified successes in every instance. I could name engines of certain classes that have been invariably successful, and in whose favor at the meeting of the Master Mechanics' Association last year the verdict was universal.

Mr. Yerrets: Can Mr. Vauclain give me any figure as to the cost of repairs of any one or of all of these engines that are on the Philadelphia & Reading Road, drawing its fast Blue Line trains? I think that would be an additional point on which we might very readily gain information.

Mr. Vauclain: I believe that the repairs to the compound engines of the Philadelphia & Reading Railroad are about 75 per cent. to 80 per cent. of what the repairs cost on the single-expansion engines. On the passenger engines there is very much better than that, probably not over 60 per cent. of what the single engines cost them for repairs in hauling the same service. That is not due entirely to the compound engines. The compounds have a slight advantage over the single-expansion engines by having a little larger wheel, and we look in compound engines for the same repairs—about the same repairs as we have in single-expansion engines. We look for a saving in boiler repairs—very much so. In cylinder repairs we look for an increased amount of repairs, due to having four pistons to take care of in place of two. Mr. Soule, of the Norfolk & Western, kept a record of this, I believe, and found that the total cylinder repairs to an engine did not exceed 5 per cent. of the total repairs; and as I told him that I would concede him twice the cylinder repairs to the compound as he had to the single expansion—it would not make any great figure in the comparison of repairs—whereas the boiler repairs were less in a very much greater proportion. We think that the compound locomotives would require about the same repairs as the ordinary single-expansion engines; under certain conditions it would be less, and very exceptionally greater—due to some carelessness, perhaps, if it were greater. I might say in this connection that I have had to father the four-cylinder compound as built by the Baldwin Locomotive Works, being the patentee of it. I have been in all sorts of service with it. I have had to meet the most earnest competition on the part of railroad companies with single-expansion engines. I heartily endorse everything Mr. Davis has said. The very highest economics that we have had with compound engines have been obtained really competing with single-expansion engines that were specially groomed and superintended and looked after by the railroads in order to knock out the compound locomotive. Where the engines were taken and properly treated, and as much care bestowed on one as the other, we have had about the minimum. The minimum economy we have effected has been on the Chicago, Milwaukee & St. Paul Road; and I think if we ever had fair treatment on a railroad we had it on that one, and that engine ran against simple engines carrying 180 lbs. of steam pressure instead of 160 lbs. We have found very high economies in running against 140 lbs. in place of 180 lbs. I acknowledge the fact that I have had a great

deal of grief in connection with compound engines; it is a baby, and at this present time we have not been building compounds for 60 years as we have single-expansion engines. We do not know all the tricks in order to get additional advantages; but we are rapidly learning them, and while I have had a great deal of grief over a great number of sick children, I have never had yet had to mourn over a corpse.

THE CURVE OF LEAST RESISTANCE IN WATER AND IN AIR.

By Merty Moulton, S.B., Newport News, Va.

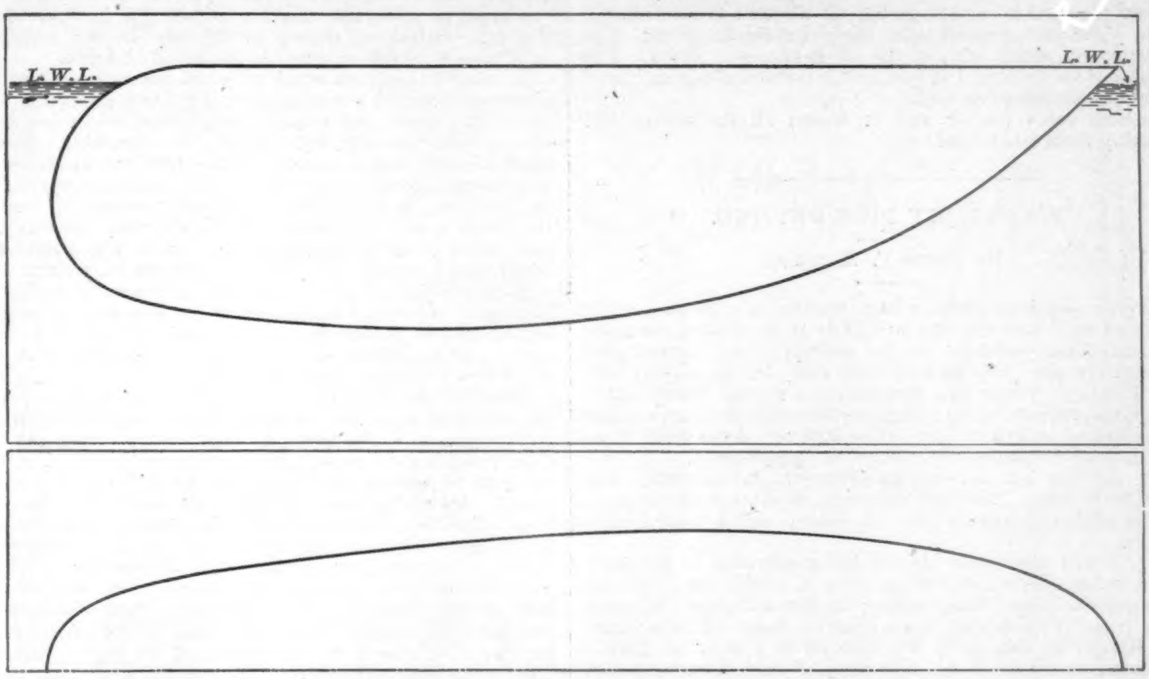
The following report of a series of very ingenious experiments, to determine the forms of least resistance in air and water, have been made at Newport News recently. We hope in the near future to give fuller particulars of the results of these investigations.

The idea of the experiments to find the curve of least resistance in water and in air was to use the friction of the medium itself (water or air) to shape the model. In water, blocks of ice of various sections and lengths were used. In air, wax cylinders of various lengths and sections were held in currents of hot air.

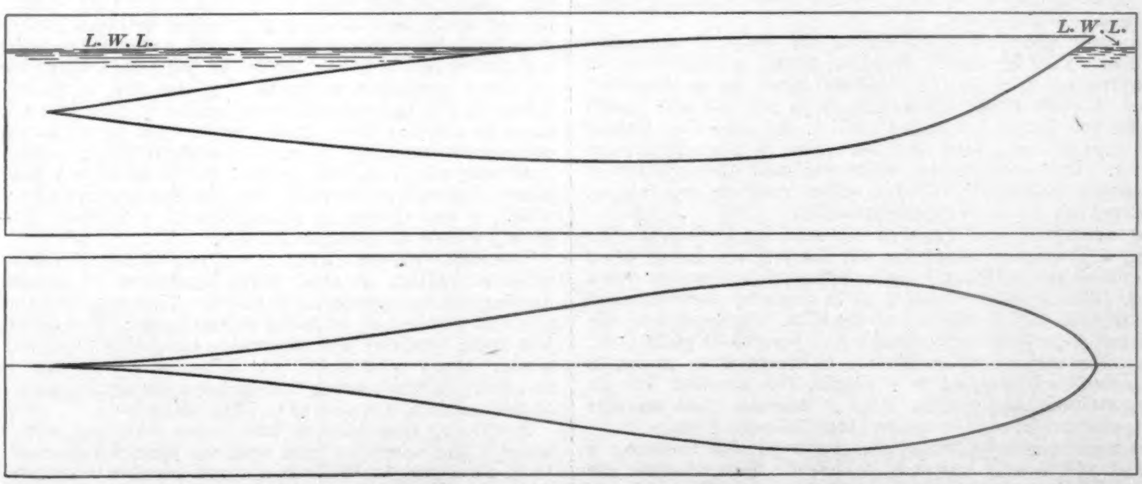
The first experiment with ice in water was performed on March 10, 1895. It will give a good idea of all the others.

The block of ice was just 9 in. square by 2 ft. long, and weighed 90 lbs. In order to tow it, a wire encircled the ice lengthwise (a deep saw-cut holding it in place). This idea was unfortunate, as the ice melted faster at the wire. In all the succeeding experiments, however, a small wooden rod was frozen in at the proper place, and the towing-wire fastened at the end. The first result after towing the ice 20 minutes, until it had shaped itself according to the wave it displaced, was very interesting and satisfactory, notwithstanding the roughness of the model formed. The under part or keel sweeps in one gradual curve from the bow almost to the stern. The stern in itself is unique, curving up rather suddenly and bending forward.

From the sides very little seems to have been taken away, which proves unquestionably that the displacement waves are caused almost entirely by the bottom.



MODEL A. RECTANGULAR OUTLINE INDICATES ORIGINAL BLOCK OF ICE, HEAVY LINES THE REMAINING MODEL. SCALE, ¼ SIZE.



MODEL B. RECTANGULAR OUTLINE INDICATES ORIGINAL BLOCK OF ICE, HEAVY LINES THE REMAINING MODEL. SCALE, ¼ SIZE.

Curious features are the almost straight sides and the square section of the remaining ice. The forward end of the deck is neatly rounded, and deck and keel meet forward in a point. The after end is also rounded, but is flooded by the curling back of the returning waters. When the ice was taken out it weighed 14 lbs. The temperature of the water remained constant at 40° F., and of the air at 41° to 42° F.

The pull on the ice was carefully measured, and gradually

decreased from 6 lbs. to 1 lb. The largest section was reduced by one half at the finish.

The model was then taken from the water and pressed into a box of prepared plaster of Paris, and the mould thus formed. Two hours later the ice could be removed, and a perfect mould remained. A cast was taken; this was templeted and the lines were carefully drawn.

All the experiments give very nearly the same lines, more or less smooth according to the section of the block. Blocks of all sections were used, beginning with square blocks 2 to 4 ft. long (4 ft. preferred) by 9 in. square; then blocks of circular, semicircular, triangular, and other sections were used, as well as blocks immersed by freezing into the ice enough to make it sink.

The only objection to the use of ice is the roughness of the model formed from it; the air-bubbles in the ice cause it to become honeycombed as it melts.

With air the results are practically the same. Cylinders of wax of various cross-sections were suspended in a specially tapered pipe and a current of hot air allowed to flow around them. The wax cylinder takes the shape the air gives. The temperature, speed, etc., of the air is carefully noted. The cylinder is then allowed to cool and is then carefully calipered to the thousandth of an inch.

In both cases (in air and in water) all the curves run smoothly from end to end.

WATER-JET PILE-DRIVING.

By James F. Hobart.

Having occasion to drive a large number of piles on a sandy sea-shore with blue clay beneath 12 to 15 ft. of sand, resource was had to the water-jet for the purpose of sinking the piles through the sand, after which they were driven at least 8 ft. into the clay. Water was supplied by a duplex Worthington pump, an ordinary boiler being erected with the pump at the water's edge, and the liquid forced through about 1,000 ft. of 5-in. piping to where the pile-driver was located. A foot-valve was put into the suction-pipe, which necessarily was about 60 ft. long. The foot-valve was built up of two flanges, a large section of pipe, a piece of leather, and a bit of rubber gasket.

Fig. 1 will give some idea of the appearance of the foot-valve, the flanges *a* and *b* being screwed to the pipes, and the large piece of pipe *c* being turned up in a lathe until the ends were true. The flanges were likewise faced off in a lathe. The clapper to this valve was formed of a piece of leather cut down, as shown in fig. 2, a piece of iron, being attached by a bolt to the clapper of the valve. Another but thinner piece of iron was placed underneath the clapper, as shown at *e*. This prevented the leather valve from collapsing under the pressure of the water.

The large piece of pipe forming the body of the valve shown in fig. 3 is, as will be seen, merely a plain piece of steam-pipe about 8 in. in diameter faced up as described above. A plain rubber gasket, fig. 4, is cut out and placed between the flange *b* and the shell *c*, fig. 1. The leather which forms the gasket and the valve is placed between *a* and *c*. This contrivance, when well and evenly screwed up, forms a perfectly tight valve, which works in good shape, and as yet has given no trouble whatever.

The water-jets were formed as shown in fig. 5, the 5-in. pipe having a T screwed upon the end thereof, and being fitted with elbows and reducing nipples, bringing its diameter down to 3 in. Strong rubber hose 3 in. in diameter were attached to the nipples, and to the end of the 50-ft. lengths of hose the water-jets were attached, consisting of lengths of plain 1½-in. pipes. The method of connecting is shown at *a*, in fig. 5. The hose being attached to a nipple, this screwed into an elbow, another nipple 6 in. long is inserted, then another elbow, and the jet-pipe is screwed into the second elbow.

The rope tackle by which the water-jet was managed is attached to the long nipple *b*, as shown. Two of these jets are used, the pipes *c* being about 15 ft. long. The piling is driven as shown by fig. 6, the two central piles being vertical, while the outside of spur piles have a batter of 3 in. per foot. It proved quite a problem to drive all four of these piles with the same machine. The spur piles could evidently be driven easily enough if a special machine were built for the same rake or pitch—namely, 3 in. per foot. But as two out of four piles had to be driven vertically, the special machine would not answer, and the low price at which the contract was taken forbade the use of two machines.

The piles were finally driven by arranging the machine as shown in fig. 7. The vertical pile having been driven as shown, the spur was erected after the machine had been racked over as far as possible, the spur pile being shown in position on top of the ground at *b*. It was placed diagonally under the hammer, as much as the width of the pile-driver would permit, as seen in the engraving. While in this position the water-jets were applied at *c*, so as to loosen up the sand at the right of the pile, causing it to work in that direction to a considerable extent, thus increasing the pitch of batter.

The foot of the pile was sharpened, as shown in fig. 8, all the cutting being done on one side of the pile, giving a one-sided bevel as shown. When this pile was driven it possessed a natural tendency to work off in a right-hand direction. This tendency was increased as much as possible by the use of the water-jets on that side, as described in fig. 7. As the driving proceeded, it was found that the pile cramped in the machine at *b* and *d*, causing the frame to be badly sprung out of shape. Driving was persevered in, and as the pile got down below the machine, as shown in fig. 9, it was necessary to move the machine to one side in order to bring the pile central, as shown by fig. 10. In this manner the spur piles were driven down to the required depth.

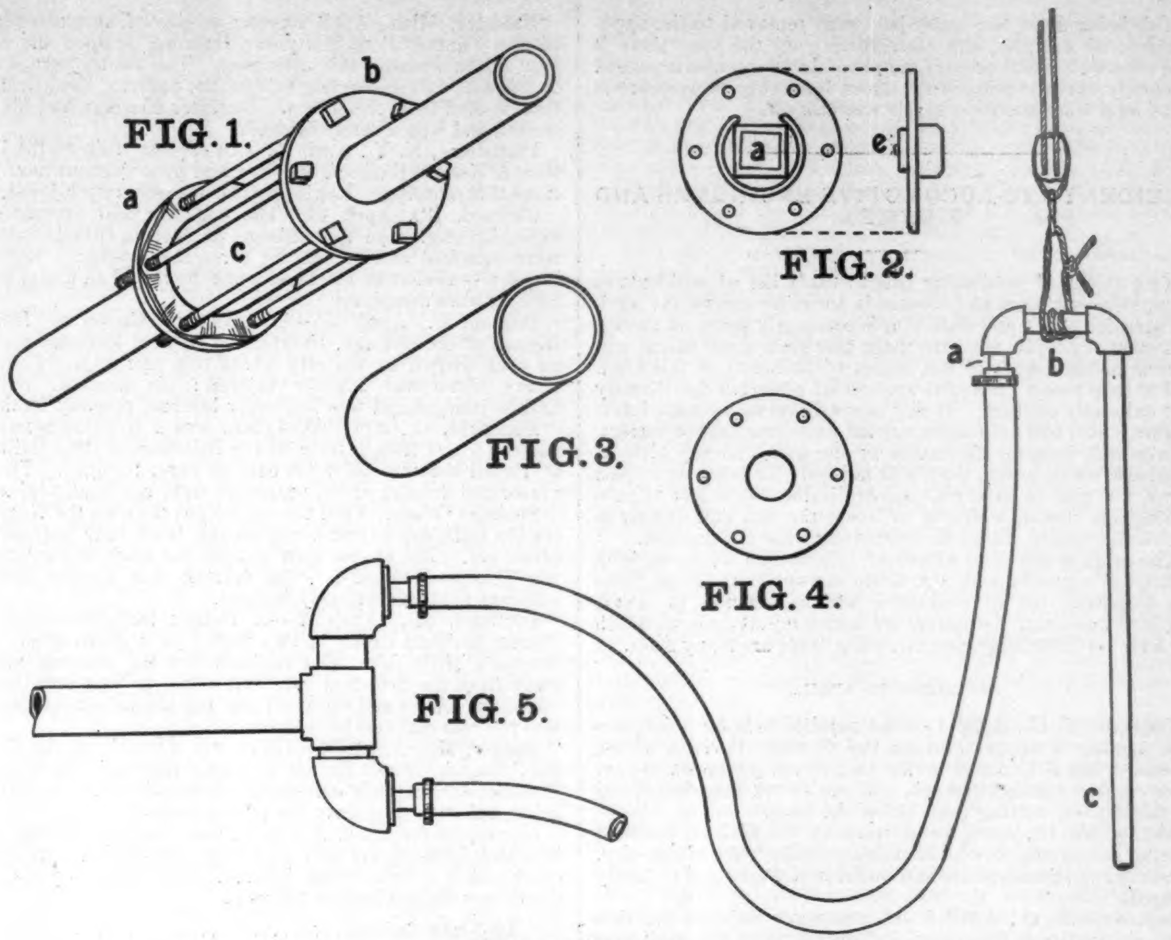
In order to ascertain whether or not the required batter was obtained, I caused a workman to dig down about 3 ft. beside one of the bents, and straight edges were set up beside each pile as nearly in line with the centre as possible. Measurement showed that the batter of the pile was 2¾ in. per foot, very close to the 3 in. required. The cramping of the pile in the machine, as above described, soon resulted in damaging the driver to such an extent that repairs were necessary. To this end a piece of 4-in. hard pine plank was bolted to the pile-driver frame. This proved a useless expedient, as the very next pile that was driven the bolts were torn out of the hard pine strengthening piece, which was not only split in several places, but cracked almost across at one or two other spots, making it necessary to replace the repairs with white oak strips 8 in. wide and 6 in. thick.

It would, as stated, have been much better to have removed the defective stand of the machine and replaced it with oak, but it seems to be the policy of some contractors to think that "anything is good enough for the man on the job," hence the necessity of making the "chip and string" repairs mentioned above. In driving these piles with the water-jet it was found most effective to place the pile in position, each pile being 25 ft. long, 12 in. in diameter at top, 6 in. at smaller end. When in position the hammer was allowed to fall lightly upon the pile, then the water-jets were applied, one upon each side, the jets were run down about 4 ft., then withdrawn and run down again at 90° from the first position. After remaining for a minute in this position, one jet was forced about 2 ft. further in the ground.

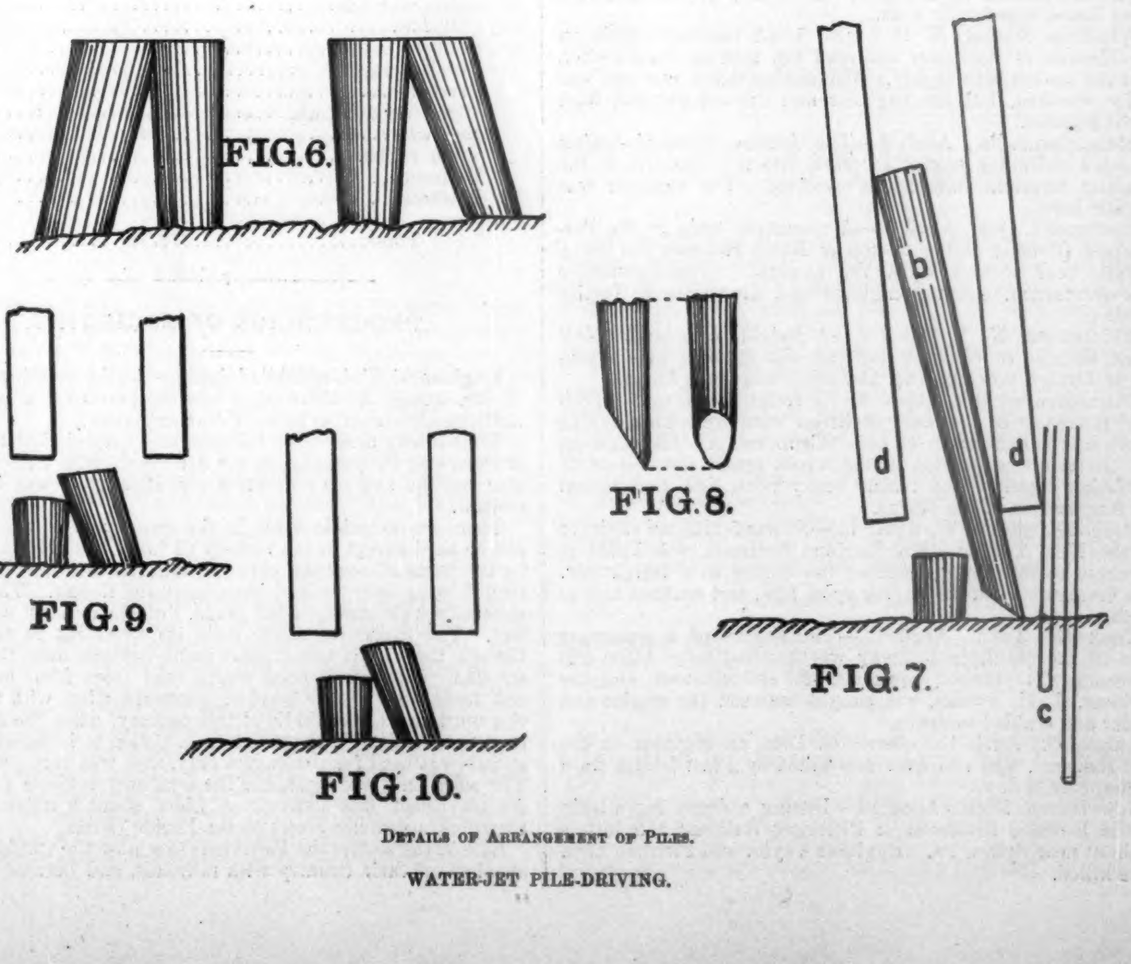
Meanwhile the pile followed the jets down, proceeding very closely with them. The piles went down about 6 ft. with this setting of the water-jets; after which they were pulled up and again sent down quartering as before. One jet was now kept about 3 or 4 ft. in the ground, while the other one was forced down to the bottom of the pile, it being made to go down gradually, accompanying the pile in its descent. After the pile had gone down about 10 ft. both jets were run down to the clay, then gradually brought up to the surface, completely loosening the sand through its whole depth. Not until this was done was the pile struck at all. A few light blows then sufficed to carry the pile down to the clay; after which it was driven by 4-ft. blows of a 3,300-lb. hammer, giving a blow of about 150,000 lbs.

The water-jets were kept in use, one at top of ground, the other at bottom of sand, being alternated by occasionally moving one up and the other down. This was done until the pile was within 4 ft. of being driven home; after which both jets were removed and the water stopped. The sand now settled closely around the pile at top of ground, and served to steady it while being driven home by very heavy blows of the hammer, drops of 12 to 15 ft. being used.

In driving spur piles it was found that they went down better if the water-jets were removed after the penetration of 15 ft. had been reached. It was not possible to strike a blow fair upon the end of the spur pile owing to the angle at which it must necessarily be driven. By removing the water-jet when nearly down, the backing of the sand at surface of the ground served to steady the pile, making its driving easier than when the use of the water-jet was continued. Several piles accidentally were driven 8 or 10 in. out of line by attaching the back fall of tackle of the pile-driver, and after getting a good strain upon the pile the sand was loosened on the side to which it was to go by means of the water-jet. After thoroughly jetting as deep as possible a pull was given upon the rope tackle referred to, and the pile easily pulled into place.



DETAILS OF APPARATUS.



DETAILS OF ARRANGEMENT OF PILES.

WATER-JET PILE-DRIVING.

This being done, the water-jets were removed to the opposite side of the pile, and after stirring up the sand there it was allowed to settle around the pile. In 10 minutes it packed so closely that the pile did not move back over three-quarters of an inch when the rope tackle was cast off.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publications will in time indicate some of the causes of accidents of this kind, and to help lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with the information which will help make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a great favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in April, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN APRIL.

Concord, N. H., April 1.—The parallel rods on a locomotive hauling a paper train on the Concord Division of the Boston & Maine Railroad broke near North Boscawen to-day. Both crashed through the cab, and one struck Engineer Wood on the left leg, cutting it off below the knee.

Montpelier, O., April 5.—A train on the Wabash Railroad coming east to-night was fired into 8 miles west of this city. Fireman Fred Smith received a bullet in his head and is fatally injured.

Sommerfield, O., April 5.—A passenger train on the Bellaire, Zanesville & Cincinnati Railroad jumped the track near Whigville this morning, and plunged over a trestle 40 ft. high. Eli Lucas, the engineer, was killed, and the fireman, Jesse Jones, was fatally hurt.

Windham Station, N. H., April 5.—A passenger train on the Nashua & Rochester Railroad ran into an open switch near the station here to-day. The engine rolled over and was badly wrecked, but the engineer and fireman escaped with slight injuries.

Philadelphia, Pa., April 6.—The failure of the air-brakes caused a switching engine to crash into the bumpers at the Reading terminal station this evening. The engineer was slightly hurt.

Sherbrooke, Que., April 8.—A passenger train on the Passumpsic Division of the Boston & Maine Railroad ran into a boulder near Smith's Mills, Vt., to-night. The locomotive was overturned, and the engineer and fireman were fatally scalded.

Middletown, N. Y., April 9.—A freight train on the New York, Ontario & Western Railroad was derailed by a wash-out at Jermyn this morning, and the fireman was killed.

Punxsutawney, Pa., April 9.—A freight train on the Buffalo, Rochester & Pittsburg Railroad went through a bridge a mile and a half north of here this morning. The engineer and fireman were buried in the wreck under the waters of Mahoning Creek. The recent heavy rains had undermined the foundations of the bridge.

Poughkeepsie, N. Y., April 13.—Edward Hill, an engineer on the New York & New England Railroad, was killed at Glenham to-day while coupling the engine to a freight car. The fireman backed the engine upon him, and crushed him to death.

Knoxville, Tenn., April 12.—The engine of a passenger train on the Southern Railway was derailed near Afton this afternoon. It plunged down a 15-ft. embankment, and the engineer, J. H. Swatts, was caught between the engine and tender and scalded to death.

Akron, O., April 13.—James G. Dice, an engineer on the Erie Railroad, was run over and killed by a fast freight train at Sherman to-day.

New Haven, Mich., April 13.—During a dense fog a train on the Buffalo, Rochester & Pittsburg Railroad ran into a washout near Sykes, Pa. Engineer Taylor and Fireman Shea were killed.

Manistee, Mich., April 13.—An engine of an express train on the Flint & Père Marquette Railroad jumped the track near South Freesoil this afternoon. The tender turned over on the cab, and so severely injured the fireman, Fred Graham, that he died from the effects. Engineer Sherman had his arm broken and was severely bruised.

Plattsburg, N. Y., April 15.—An express train on the Delaware & Hudson Railroad was wrecked by a washout near Port Kent this morning. Engineer Rich was severely injured.

Chicago, Ill., April 16.—The engineer and fireman of a switching engine on the Chicago & Eastern Illinois Railroad were attacked and robbed by three men to-day. Engineer Bigelow was shot in the head when he raised an alarm as the robbers were escaping.

Dayton, O., April 18.—A passenger train on the Ironton Branch of the Chicago, Hamilton & Dayton Railroad ran into an open switch in the city yards this morning. Engineer Harry Kline was slightly injured; his fireman, William Smith, jumped and was internally injured, possibly fatally.

Mansfield, O., April 20.—There was a collision between a passenger and freight train on the Baltimore & Ohio Railroad, at Fredrickstown, 20 miles east of here, to-night. The engineer and fireman of the passenger train are fatally injured.

Spokane, Wash., April 21.—A freight train on the Northern Pacific Railroad struck a cow on the track near Garfield this afternoon. The engine then jumped the track, instantly killing Thomas Eckersly. The fireman was thrown into an adjacent field and seriously injured.

Portland, Me., April 22.—A freight train on the Grand Trunk Railroad broke in two to-day on a down grade near Norton's Mills, Vt. The engineer ran the forward section away from the detached cars, but while he was standing between the tender and the front car, the second section crashed into the rear end and killed him.

Banger, Me., April 29.—There was a wreck on the Bucksport Branch of the Boston & Maine Railroad this evening. Fireman John Arthur was caught in the *débris* and so severely injured that he died from the effects thereof.

Our report for April, it will be seen, includes 20 accidents, in which 10 engineers and 10 firemen were killed, and 7 engineers and 2 firemen were injured. The causes of the accidents may be classified as follows:

Air-brake failure	1
Break-in-two	1
Broken parallel-rod	1
Cattle on track	1
Collision	1
Coupling cars	1
Derailments	3
Landslide	1
Misplaced switches	2
Run over	1
Train robbers	2
Unknown	1
Washouts	4
Total	20

PROCEEDINGS OF SOCIETIES.

Engineers' Club of Philadelphia.—At the meeting of May 18 Mr. James R. Maxwell, a visitor, presented a paper on Railway Construction in the Peruvian Andes.

After briefly describing the area and natural characteristics of Peru and its population, the principal cities were enumerated and the character of the Andes Mountains was fully described.

There are no public roads in the country on which vehicles can be used except in the vicinity of Lima, the old roads made by the Incas all over the part of South America that they controlled being only for foot passengers and llamas. They were generally well arranged for grade, but the location was often bad. The Spaniards made little improvement in roads, although they built some good stone bridges over the larger streams. There is a good wagon road from Lima to Callao, and these were all the ways of communicating with the interior until about the middle of this century, when the first railroad was built. It extended from Callao to Lima—about 7½ miles—was used for passengers only, and was very profitable. The work on it was light, and the total cost not over $150,000. Another road was built from Lima, about 8 miles long, to Chorillos, a summer resort on the Pacific Ocean.

Late in the sixties the Peruvians saw how the Chilians were opening up their country with railroads, and became anxious

to develop their own in the same manner. The government had a large revenue from the sale of guano, of which it had a monopoly, and so it easily floated a loan in England and organized a system of public works. A number of roads were projected, several of which were to cross the Andes, but the greater number were only local, reaching in from the coast to some productive locality.

A survey made to ascertain the expense of extending the railroad from Mollendo to Islay, only 6 miles along the coast, showed that it would cost $1,500,000.

The Board of Public Works, composed of engineers—some educated in this country, but most of whom had studied in Europe—fixed the standards for maximum rates of grade, minimum radii of curves, minimum length of tangents between the curves in opposite directions and the rate of compensation on curves, with some of the details of construction. The maximum grade was fixed at 4 per cent. On curves of 120 metres radius the grade was fixed at 3 per cent., while with 600 metres radius no compensation was required, and between these limits the rate was made proportional. The minimum length of tangents on curves turning in opposite directions was made 30 metres. The standard roadbed was 14 ft. wide; cuts, 16 ft. at sub-grade; through bridges, not less than 14 ft. in the clear; tunnels, 15.75 ft. at the springing line of the arch and 18 ft. high inside; minimum thickness of masonry lining, 16 in. The gauge of most of the roads was 4 ft. 8½ in., but there was one road of a metre gauge and a small one of 3 ft. 6 in. The contracts for most of these roads were let in 1869.

Mr. Maxwell then described in detail the construction of the roads from Chimbote up the valley of the Rio Santa, 165 miles, to Recuay, and the southern system, the largest in Peru, consisting of the road from Mollendo, 107 miles, to Arequipa; from there, 218 miles, to Puno, and another, from Juliaca, 210 miles, to Cuzco, of which only 112 miles are finished. The road from Juliaca runs nearly due north and crosses the summit of the eastern range at an elevation of 14,200 ft. When finished, the lowest elevation on the Cuzco branch will be 10,050 ft. above tide.

The most celebrated of the roads is the Ferro Carril Central del Peru. Starting at the docks in Callao, it keeps rising until, at 106 miles from the coast, it reaches a height of 15,666 ft. (about that of Mount Blanc). It then descends, and in 30 miles falls 3,489 ft. When completed 264 miles farther, it will reach the navigable waters of the Amazon, and this extension will probably not cost more than half as much as the finished portion. There are eight switchbacks on this road, four of them being double. There are 57 tunnels in a distance of 24 miles, mostly through rock spurs. Work was begun on this road in 1870, the track being laid to Chicla in 1875. It was resumed in 1890, and track was laid into Oroya on June 10, 1893. All of this work was done at an altitude above 12,000 ft., the most difficult and important of it, containing the two largest bridges and eight of the tunnels being above 15,000 ft.

OBITUARIES.

Frank Scott.

MR. FRANK SCOTT, the Vice-President and Treasurer of the Damascus Bronze Company, died at his home in Pittsburgh on the evening of Saturday, April 20. Mr. Scott was born in Pittsburgh on October 6, 1857, and has passed his whole life in that city, where he has made a name for himself as an energetic and capable business man. In his position as Vice-President and Treasurer of the Damascus Bronze Company, and as senior partner of the firm of Scott & McLean, iron brokers and dealers, he had made many warm business friends. Mr. Scott was not married, and had always made his home with his mother.

Arthur Mellen Wellington.

MR. A. M. WELLINGTON, the well-known civil engineer, died in New York City on the evening of Thursday, May 16, from heart failure following a surgical operation. He had been an invalid for over a year from a chronic affection of the kidneys, and an operation was performed on May 15, with the hope of relieving it, but with fatal results.

Arthur Mellen Wellington was born in Waltham, Mass, December 20, 1847, and was descended from an old New England family, which had resided in Lexington, Mass., for more than a century. He was educated at the Boston Latin School, and studied civil engineering in the office of John P. Henck, of Boston. He was engaged for more than 20 years in miscellaneous engineering work, principally upon railways, and including the Blue Ridge Railway, in South Carolina; the Dutchess & Columbia Railroad, in New York; the Buffalo, New York & Philadelphia Railroad; the Michigan Midland Railroad; the Toledo, Canada Southern & Detroit Railroad, and the New York, Pennsylvania & Ohio Railroad. In 1881 he was made Chief Engineer of the Mexican Central Railroad, and he spent the three years following, until 1884, in the service of the principal Mexican railways. He was Chief Engineer of the Interoceanic Railway, from Vera Cruz to the City of Mexico and the Pacific Coast, and the Assistant General Manager of the Mexican Central Railway.

As a result of his wide experience in railway location, he published in 1877 a treatise on the subject, which soon attained a wide popularity. In 1884 he turned his attention to technical journalism, and after two years' service as an editor of the *Railroad Gazette*, he became in 1887 one of the editors-in-chief and proprietors of *Engineering News*. The remainder of his life was spent in this work, interrupted only by service as Consulting Engineer to various enterprises.

He published his first work, "The Computation of Earthwork from Diagrams," when only 24 years of age. The first edition of his most important work, "The Economic Theory of Railway Location," was published in 1877. In 1887 he published a revised and much enlarged edition of this work, and it soon became the standard treatise on that subject. He was also the author of various minor technical books.

He was a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the Canadian Society of Civil Engineers, the British Institution of Civil Engineers, and the Engineers' Club of New York City. He contributed many important papers to the published transactions of these societies, and was widely noted as an authority.

In 1892 Mr. Wellington became interested in the subject of thermodynamics, and as the result of his studies he invented an entirely new system of transforming heat into mechanical work, designed to effect this transformation with a much smaller percentage of loss than the best existing steam engines. He devoted his best energies to the engrossing task of developing this invention, and labored so incessantly that his health failed under the strain imposed upon it. He had practically completed his invention, however, before this time, and was only awaiting the hoped-for restoration to health to undertake its commercial development.

Mr. Wellington married Agnes Bates, a sister of Major Alfred E. Bates, U. S. A. His wife and a daughter survive him.

Manufactures.

PINTSCH VERSUS ORDINARY ILLUMINATING GAS FOR CAR-LIGHTING.

THE Safety Car Heating & Lighting Company have installed a very interesting exhibit in their office at 160 Broadway, New York. They have two tanks, one of them filled with compressed Pintsch gas and the other with compressed city gas. These tanks are connected with burners of various kinds in such a way that either kind of gas can be turned on at will. With any of the burners the Pintsch gas gives a brilliant light. As soon as the street gas is turned on the light at once begins to languish, and fades away until less than a third as much light is emitted, giving a very inferior illumination.

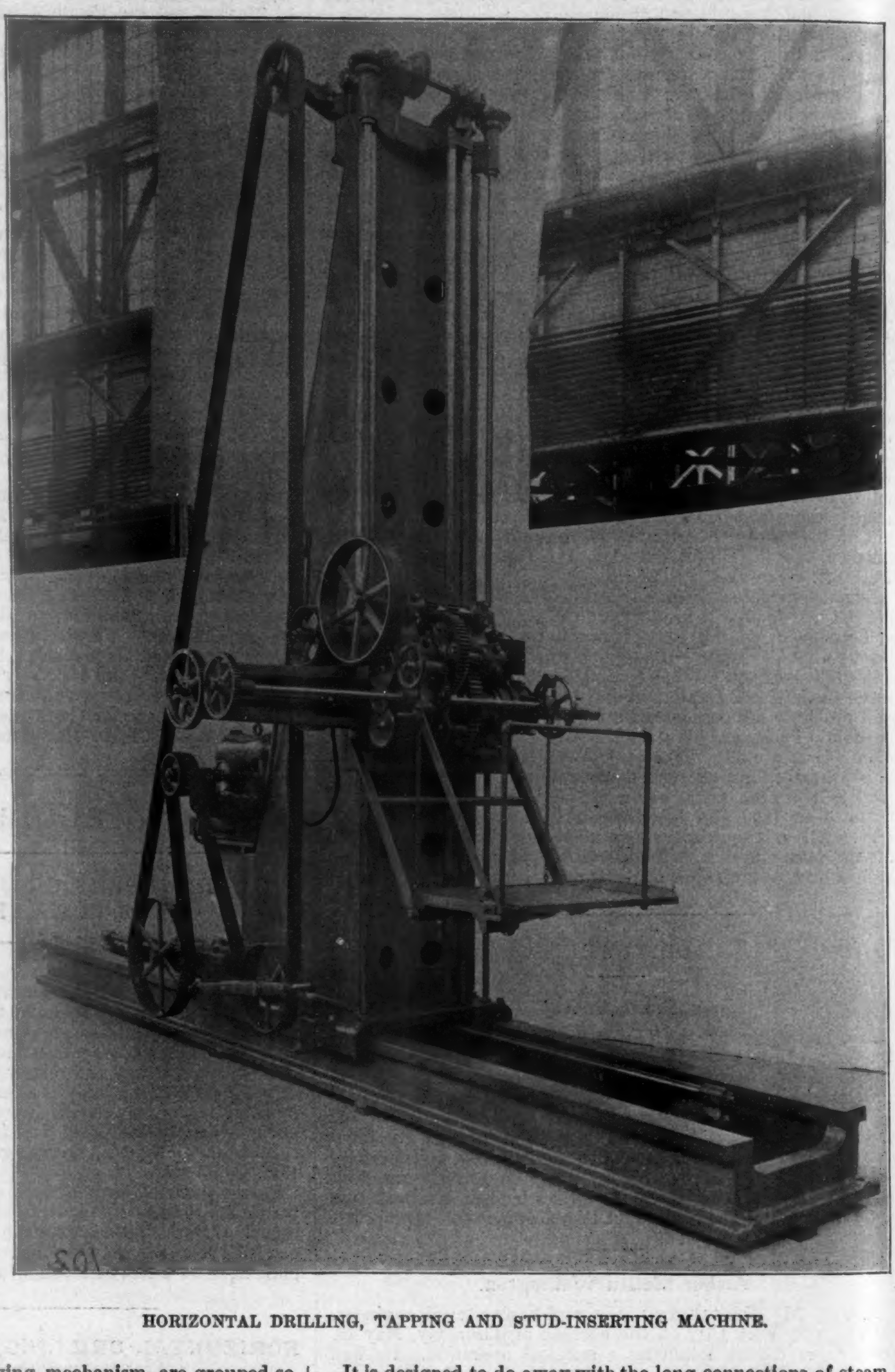
A new inverted burner is also exhibited which is not affected by drafts, such as are liable to blow out most of the lights of this character. This enables the products of combustion to be carried out of the car by a flue, whereas many burners of this class have no direct connection with "out of doors."

HORIZONTAL DRILLING, TAPPING AND STUD-INSERTING MACHINE.

IN our last issue we published a short description of the electrically driven tools that are in use in the shops of the Southwark Foundry & Machine Company's works, in which an allusion was made to a milling machine that was built by the firm of William Sellers Company. Through the courtesy of this company we are now enabled to present an engraving of a similar machine, but without the milling feed and with a some-

what different arrangement for driving, that is in use at the yards of the Cramp Ship-building & Engine Company.

This horizontal drilling, tapping and stud-inserting machine is capable of operating vertically upon a surface from 3 ft. to 14 ft. above the floor, and 16 ft. horizontally, the whole upright carrying the machinery travelling upon the bed shown. This bed may be increased in length any reasonable amount desired, thus prolonging the horizontal travel accordingly. The drilling-head carries all the operating machinery, as well as the platform for the operator, so that whether the machine is working in its highest or lowest point, or anywhere along the bed, all the movements of raising and lowering the drilling head or moving the column horizontally may be made from the platform, quickly or slowly at will, and with the greatest nicety. The machine is driven by an electric motor carried on a bracket upon the back of the column (or it may be driven entirely by belt), and the electric system is such as to give 30 speeds forward and 30 speeds backward, a range so great as to adapt it for any class of work. The horizontal movement of the column upon the bed and the vertical movement of the drilling head upon the column are capable of a maximum of 20 ft. per minute, and thus permit rapid adjustment. This is done by means of the horizontal and vertical screws, the former being fixed. The belt system from the motor includes a tightening frame, so that the belt is always in proper tension whether the drilling head is at the top or bottom or at any intermediate point. The feeds to the spindle are given through the Sellers well-known friction disks, and in two series for fine and coarse, with a wide range to each, the maximum being about $\frac{1}{4}$ in. per revolution of spindle. Particular attention is called to the fact that the power is not transmitted through long shafts, but is applied directly by the belt to the drilling head, the two square shafts shown being simply for engaging and disengaging the clutches for the vertical and horizontal movements. There is, therefore, an entire absence of the torsional strains in the long transmitting shafts used in other machines. The levers to manipulate the horizontal and vertical movement of the drilling head, and to engage and disengage the feeds, start, stop and reverse the driving mechanism, are grouped so as to be handled by the operator from one position, and the handles to manipulate the spindle are also grouped, thus permitting the largest possible product. As we have said, it is a similar machine incorporating milling feeds that is in use in the Southwark shops, the importance of which, in combination with the great range of speeds mentioned, will be appreciated. The operator's platform is carried by a swing frame, so that as the head approaches the bed the platform accommodates itself to the lowest point.



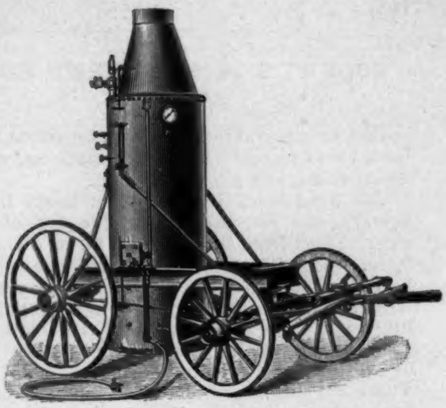
HORIZONTAL DRILLING, TAPPING AND STUD-INSERTING MACHINE.

A NEW STYLE OF PORTABLE BOILER.

The engraving shows a new style of portable boiler, mounted on road wheels, so that it may be easily moved from place to place, recently put upon the market by the W. A. Crook Brothers' Company, of Newark, N. J.

It is designed to do away with the long connections of steam pipe heretofore necessary in carrying steam considerable distances through pipes to rock drills, hoisting engines, steam pumps and other machinery, which has always been an expense and inconvenience. By the use of this new style portable boiler the steam generator may be brought close to the work. The cut is to a great degree self-explanatory. It shows a vertical tubular boiler which is mounted upon broad-tired road wheels in a very substantial manner. The machine is furnished complete with a pole and whiffletrees. The whole

outfit is light, and can, it is claimed, be hauled over the roughest of roads without any danger of breaking down. Sixteen



A NEW STYLE OF PORTABLE BOILER.

sizes are furnished, ranging from 5 H.P. to 75 H.P. Up to 18 H.P. three or four men can push the machine about very easily.

THE COMBINE WATER-TUBE BOILER.

The combine safety water-tube boiler, illustrated in this issue, is patented and manufactured by L. M. Moyes, 411–413 Walnut Street, Philadelphia. The boiler is "sectional" and of the class of the water tube type, in which the steam and water drums are arranged and located transversely to the flow of gases from the furnace to the outtake to the chimney. The illustration shows (fig. 1) transverse sections through the front steam and water drum and furnace, and through the rear steam and water drum. Fig. 2 shows a detail of "tubes," "manifolds" and "distributing drums" assembled. In elevation (fig. 3) the boilers present a neat and compact appearance, the steam and water drums are encased in blocks of "makite" moulded to the radius of drums, the bench formed by the break in the lines of brick-work in the rear of rear steam and water drums, as shown in elevation, is utilized for the carrying of the main flue, with a number of batteries, or the stack, with one battery or one boiler, reducing very considerably the floor space required. The fronts of boilers are of cast iron and are supported entirely free of the brick-work around boiler; the frame upon which the steam drums rest is formed of I beams braced and tied so as to be self-supporting, and is also independent and separate from the brick-work. The side elevation presents a fairly good idea of the arrangement of the boiler, the tubes (standard 4 in. × 18 ft.) on an angle of about 45° are expanded at the upper end into the tube-sheet in the steam-drum, and the lower end into the tube seats in manifolds. The manifolds for power plants are open hearth cast steel, thoroughly annealed, each manifold having an area almost equal to an 8-in. tube. Opposite each tube is a hand-hole closed with an inside and outside plate of steel; the seat on outside face of the manifold and face of the outside plate are machined so as to form a perfect joint without packing. The inside plate also forms an almost perfect joint without packing. Each manifold is connected to the distributing drum by a 5-in. nipple, and for ordinary high pressure the distributing drums are also of annealed steel. The sections are connected to and with each other by circulating tubes set at the same angle as the tubes, and are 5 in. in diameter. Each distributing drum has a separate blow-off valve. In the working of boiler the gases, as will readily be seen, have a very long contact with the heating surface in their flow from furnace to outtake. As is indicated by the arrows, the circulation of water and flow of steam generated in tubes is upward in the two forward sections into the two front drums, with ample disengaging space, thence by the connecting devices to the rear drum, into which the feed is also delivered and downward in the rear section. The ingenious and mechanically designed connections between sections provide for all expansion strains. The steam drums rest on I-beams in such manner as to remove all carrying strains from the tubes.

The transverse section through the front steam drum shows the separator dry pipe in each drum. The section through rear drum shows the feed-water sumpt. The feed pipe is connected to the sumpt, and into it the feed water is delivered. This sumpt is of cast iron, on which a light cast-iron cover is loosely placed, and which continues to within a short distance of the end of the sumpt, forcing the feed to travel its entire length, and in doing so acquiring the temperature of water in circulation in the boiler before coming in contact with the same, thereby depositing many of the impurities in solution and suspension, which are removed by the use of the blow-off valve attached for that purpose. Should the deposit in the sumpt accumulate through inattention to such an extent as might interfere with the passage of the feed through sumpt, the cover being placed on loosely would be forced off by the accumulating pressure, due to the feed delivery, and thus enable the feed to enter into the circulation. The circulating and compensating tubes by which the steam drums are connected are shown in the side elevation, as well as the cross steam pipes on the top of the drums, to which safety valves are attached. These cross pipes are of steel with flanges cast on. A tube from any section in boiler can be easily removed without interfering with the adjoining tubes. The removal of a deposit from the inner surface of tubes is made either by introducing the scraper at the lower end through the hand hole, or at the upper end from the steam drum. The smallest steam drum used on this boiler is 42 in. in diameter, giving ample space for men to work in when cleaning the tubes. The chamber at the lower end is also sufficiently roomy for cleaning. The facilities for cleaning tubes has been based on the practice of many years' experience with this type of boiler. A specially designed scraper and handle is used. The cut of detail (fig. 2) shows the manner of connecting the tubes to the manifolds, as well as the connections between manifolds, and the connections between manifolds and distributing drums. The hand holes shown in the distributing drums are covered and protected in the same manner as those in the manifold, the same fittings being used in both cases. An important feature in the combine boiler is due to the possibility of shipping the boiler as an almost completed unit. Each boiler is shipped in three sections, the sections consisting of a steam drum, the tubes, the manifolds and the distributing drum. These are assembled and tested at the works,

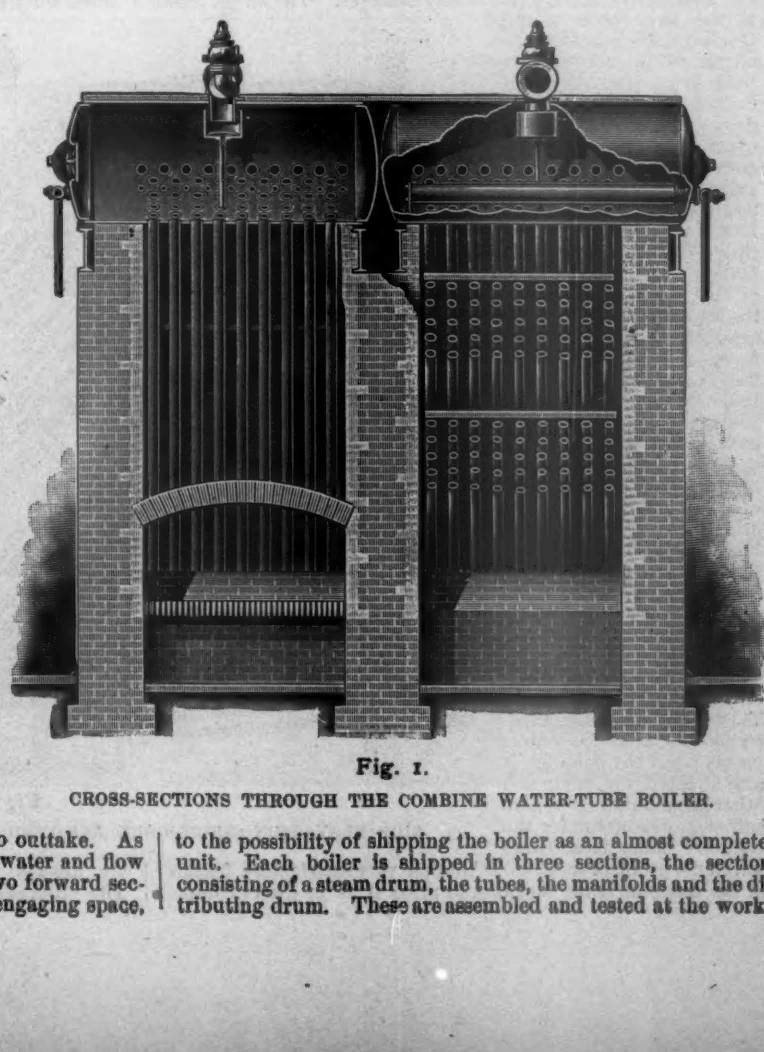


Fig. 1.

CROSS-SECTIONS THROUGH THE COMBINE WATER-TUBE BOILER.

only requiring the connecting of the same at the point of erection to form the perfect boiler. All sections are connected by ex-

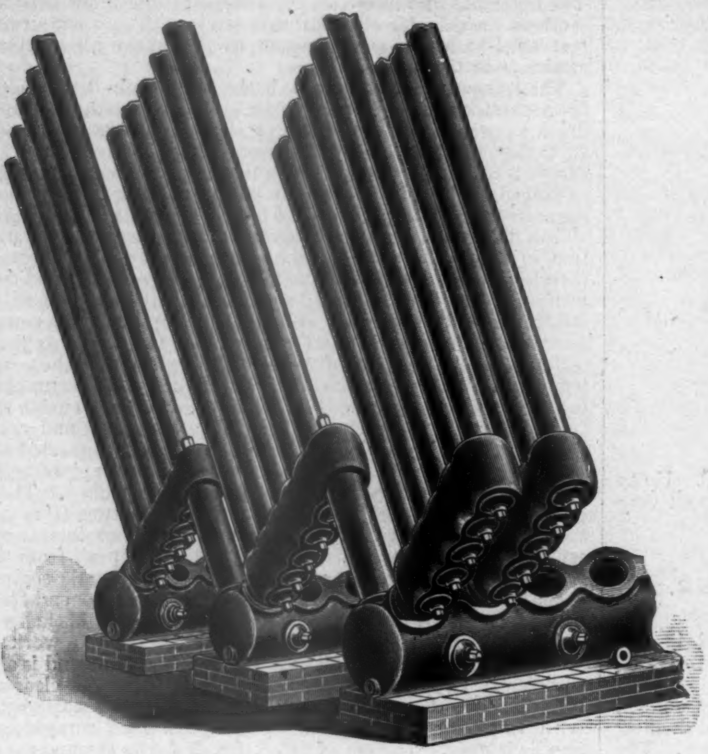


Fig. 2.

DETAILS OF TUBES IN THE COMBINE WATER-TUBE BOILER.

panded tubes or nipples, there not being a single bolt or threaded connection in the entire combination. The tubes forming the heating surface are practically straight. The slight curve in the two tubes in each section made necessary for alignment in entering tube holes in the drums is practically done at the tube mills during the process of manufacture. The tubes with curved ends are in every respect interchangeable between the different sections. It will also be observed that there are no departures from the established lines of the standard boilers of the water-tube type. The assemblage of heating surfaces, the building up of the same with standard tubes, drums and manifolds, and their relation to each other, the travel of gases in contact with heating surfaces, the circulation of water and flow of steam due to the devices used are identical in their dispositions, as in the better-known boiler, with which Mr. Moyes was for so many years connected.

This takes the combine at once from out the ranks of the experimental class. The builder will make a specialty of boilers for power plants; but the combine is also adapted for office and other large buildings where sufficient head room for the ordinary boiler is at times a difficult problem to solve. Another very satisfactory feature in the combine is the fact that in price it is in direct competition with the return fire-tube boiler. It is built in units ranging from 50 H.P. to 600 H.P., and is capable of carrying a working pressure up to 200 lbs. per square inch.

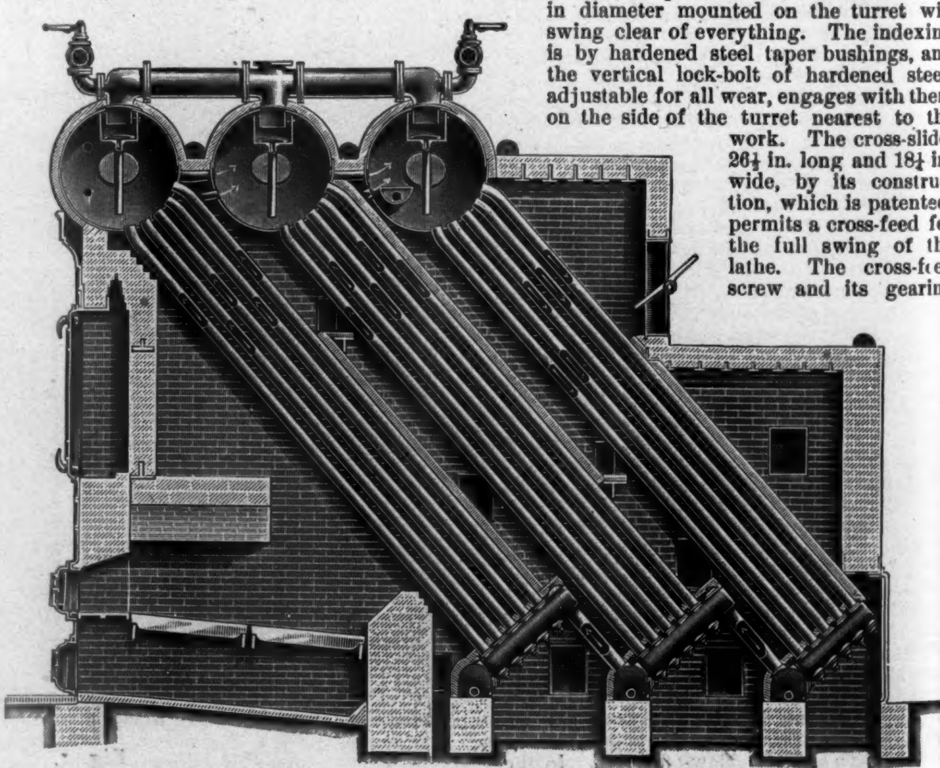


Fig. 3.

SIDE ELEVATION (BRICKWORK REMOVED) OF THE COMBINE WATER-TUBE BOILER.

BOGERT'S 28-IN. TURRET ENGINE LATHE.

THE two engravings herewith represent front and back views respectively of this machine, which has 28 in. swing and a bed 8 ft. long.

The head stock is fitted with boxes lined with nearly pure tin, and adjustable for all vertical wear. The front bearing is 4½ in. in diameter and 6¼ in. long. The front cap is held and adjusted by four 1-in. bolts, and, like the back cap, is constructed with an oil-cup, for the continuous supply of the lubricant. The spindle of hard crucible steel has a 2¼-in. hole through its axis. The end thrust is taken by hardened steel collars ground perfectly parallel. The cone has four steps 4⅝ in. wide. The double back gearing is frictional, and has the two ratios of 5 to 1 and 25 to 1.

In the manufacture of large valves or heavy pipe fittings a great saving may be effected thereby, as with back gearing of 25 to 1 engaged there is ample power to pull pipe-taps up to 12 in. in diameter, and by shifting the lever as soon as the counter-shaft is reversed the pipe-tap may be backed out five times as fast as it went in. The whole back gearing may be also disengaged, and the cone alone will drive the spindle. By varying the respective sizes of the face-plate gear and the back-shaft pinion, any desired power or speed ratios may be obtained. This capacity for variation, to suit different conditions of work, is peculiar to this device, and it may be justly considered an important invention. Furthermore, the frictions being on the back-shaft, not inside the cone, are at all times open to inspection, oiling, or adjustment; and they can be so constructed that the greater the ratio of back gearing, the greater the surface of frictional contact.

The turret is 18 in. in diameter, usually made six-sided, and bored for six 3-in. holes. An open and shut die-holder 15 in. in diameter mounted on the turret will swing clear of everything. The indexing is by hardened steel taper bushings, and the vertical lock-bolt of hardened steel, adjustable for all wear, engages with them on the side of the turret nearest to the work. The cross-slide, 26½ in. long and 18¼ in. wide, by its construction, which is patented, permits a cross-feed for the full swing of the lathe. The cross-feed screw and its gearing are always protected from chips by a telescopic slide. The cross-slide anchor, 16 in. long, and secured by two 1-in.

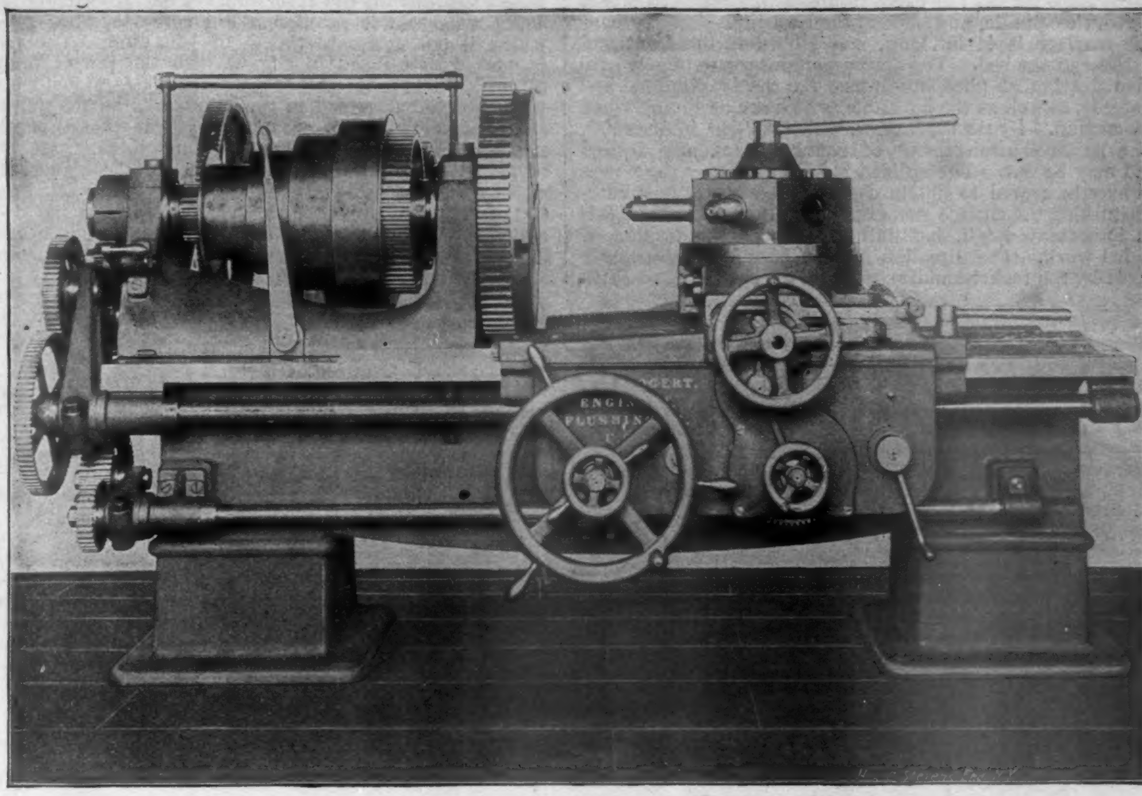


FIG. 1.—FRONT VIEW.

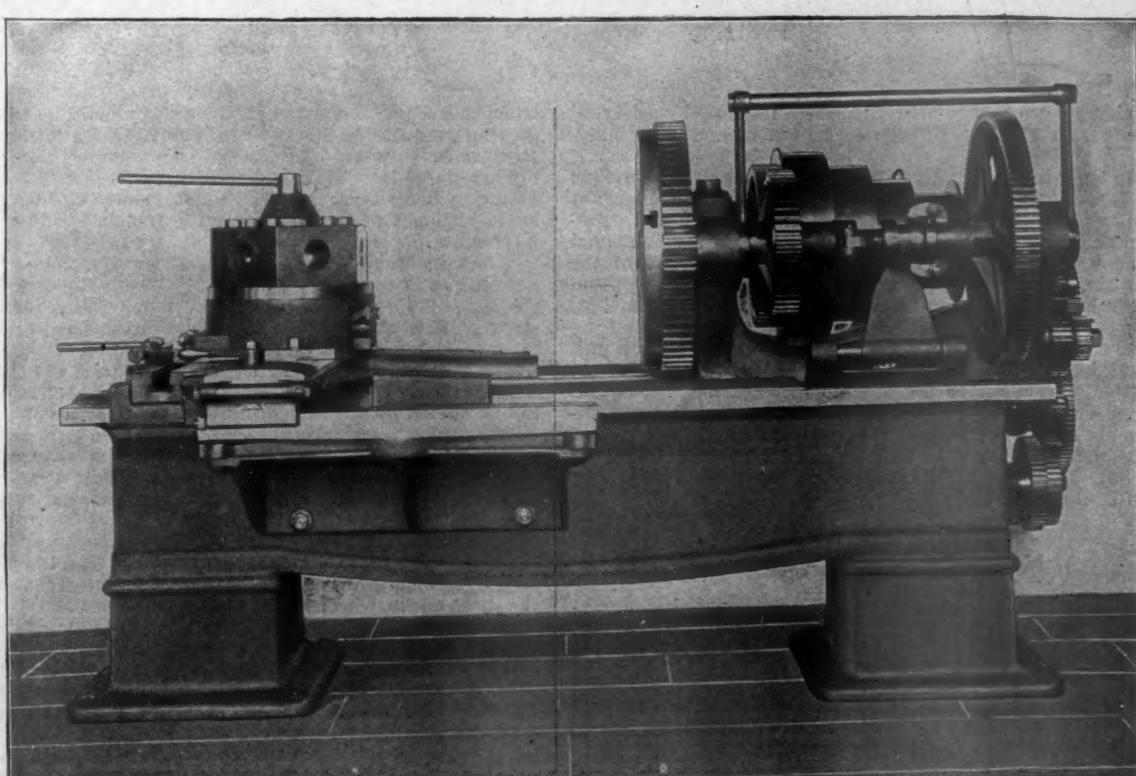


FIG. 2.—BACK VIEW.

BOGERT'S PATENT 28-INCH TURRET ENGINE LATHE.

bolts, eliminates all vibration between cross slide and carriage. Suitable stops permit the exact return of the turret tools into line with the spindle, and control their setting.

The carriage is 44 in. long, and gibbed to the front and back shear of the bed. The apron contains separate powerful friction gearing of phosphor-bronze for the longitudinal and cross-feeds, as well as the half nuts, which are used only when screw-cutting. By the lead-screw, which is 2$\frac{1}{4}$ in. in diameter, with a suitable arrangement of change gears, any desired thread may be cut. The splined-rod which drives the power feeds may be geared to obtain a sufficiently coarse feed without disturbing the change gears operating the lead-screw ; this is an important detail, facilitating the rapid production of threaded work. The direction of all power feeds is instantly changed by the rocker-handle shown on the head stock. With the change gears regularly furnished the usual variety of threads from 1 to 16 per inch may be cut without compounding.

The taper-turning attachment, which is patented, is unique in this most important respect, that it is instantly engaged or disengaged by the movement of a single handle, making possible the boring or turning of contiguous straight and tapered surfaces without loss of time. The proper setting of the taper-bar, which is 36 in. long, is determined in the usual manner by a scale reading in thirty-seconds of an inch, to 4 in. taper per foot both sides of the centre line.

The counter-shaft is fitted with double patent friction pulleys 21 in. in diameter and 5 in. face. It should make from 160 to 200 revolutions per minute forward and backward. Whenever desired, special three and four-jaw chucks are furnished to facilitate the rapid handling of work.

The weight of the lathe with taper attachment is 7,500 lbs.; without, 7,000 lbs. These machines are manufactured by John L. Bogert, Flushing, N. Y.

McKEE SLACK ADJUSTER.

The brake adjuster, illustrated in the accompanying engravings, is the invention of Mr. M. E. McKee, of St. Paul, Minn., and is being manufactured and introduced by the Q. & C. Company, of Chicago.

This device embodies several novel features, the principal one being the use of an auxiliary or take-up cylinder actuated by air from the brake cylinder, which supplies the requisite power, and a screw-threaded pull rod and ratchet mechanism, by which the cylinder or floating level, as the case may be, is adjusted in position.

Several forms of this adjuster have been made, and the one illustrated has been proved by experience to be one of the most practical and efficient. Referring to figs. 1, 2 and 3, which show the adjuster as applied to a 10-in. passenger brake cylinder, the cylinder lever *A* is fulcrumed on the pin *B* and the jaw *C*. This pin slides in the slot in the malleable casting or stirrup *D*, which is bolted to the lever bracket on the cylinder-head *E*. The jaw is held in position by the screw-threaded rod *F*, on which is cut a square thread of $\frac{1}{4}$-in. pitch. The rod *F* is formed with a T end to engage with the jaw *C*, and passes through a hole in the end of the stirrup. A ratchet-wheel, *G*, with an internal thread in the hub works on the pull rod *F*, and is prevented from moving away from the stirrup by the small bracket *H*. A ratchet lever and pawl, *I*, are pivoted on the outside of the hub of the ratchet wheel, and are actuated by the piston-rod *K* of the take-up cylinder *L*. From the end of the take-up cylinder a $\frac{1}{2}$-in. pipe leads to the air-brake cylinder, which it enters at such a distance from the end that if the brake piston travels beyond the predetermined length, air is admitted through the small pipe to the take-up cylinder ; when this occurs the piston of the small cylinder is forced out, moving over the ratchet lever and rotating the ratchet wheel about one-eighth of a revolution. The screw thread of the ratchet wheel thus moves the pull-rod *F*, and with it the end of the cylinder lever *A* $\frac{1}{32}$ in., which insures a fine and regular adjustment of the brakes and a frequent action of the mechanism.

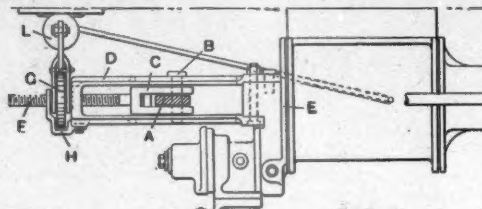


FIG. 1

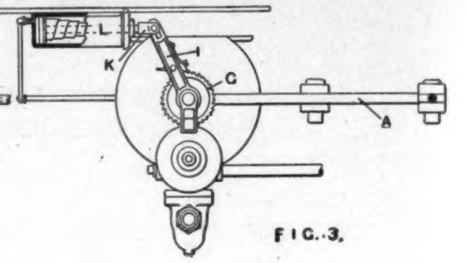


FIG. 3.

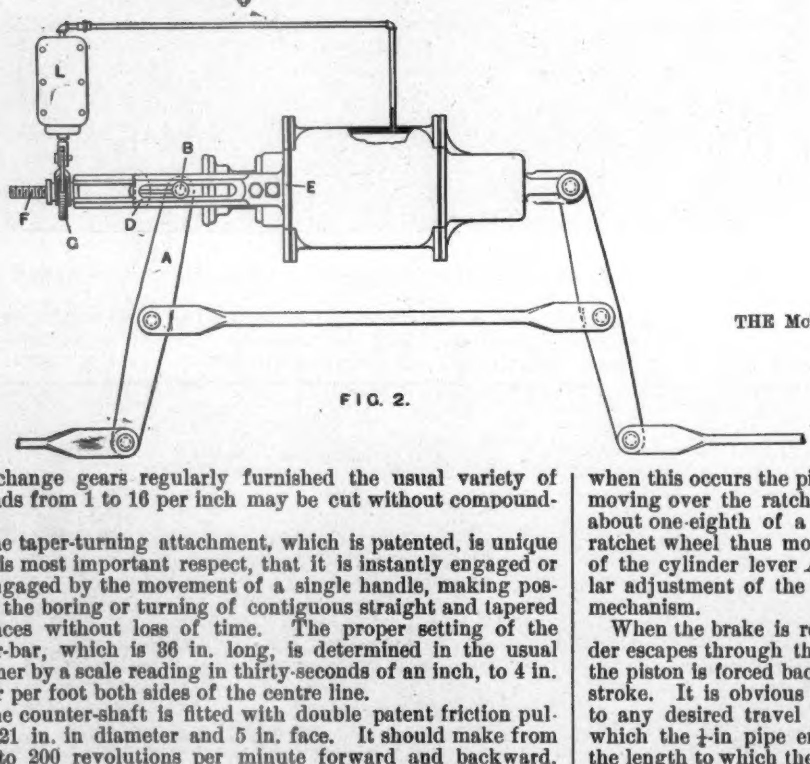


FIG. 2.

THE McKEE BRAKE SLACK ADJUSTER.

When the brake is released, the air from the take-up cylinder escapes through the back-head of the brake cylinder and the piston is forced back by a spring into position for another stroke. It is obvious that the brake piston can be adjusted to any desired travel by varying the location of the port by which the $\frac{1}{2}$-in pipe enters the brake cylinder, and that once the length to which the stroke is to be adjusted is fixed, it cannot be altered by any tampering with the adjustment.

After three years' careful experimenting the form here illustrated has been adopted on account of its advantages of simplicity, decreased cost, both for application and maintenance, its comparative immunity from dirt and snow, and accessibility.

Since only $\frac{1}{32}$ in. slack can be taken up at one application of the brakes there is no liability for the piston travel to be shortened by an emergency application to such an extent that binding the shoes on the wheel while running might recur.

No practical objection whatever has been found in three years' regular service against adjusting the piston travel at the cylinder lever or for freight cars at the floating lever, and the adjusters illustrated above have been in use on passenger and freight cars on the Great Northern Railway, running both on short distance and trans-continental trains, in the latter service having been through snow blockades in the Cascades and the sand and dust of Northwestern summers in the Dakotas, and have so far never cost a cent for repairs or failed to perform the work in any particular. There is nothing in this device which is liable to get out of repair ; the only part ever needing renewal being the packing leather in the small cylinder, and this has not yet been the case in any of the adjusters so far in service.

AERONAUTICS.

UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN ENGINEER.

A NEW PARACHUTE.

WE find in a recent issue of *La France Aérienne* the design for the application of a parachute to a balloon illustrated herewith. It is the invention of M. Emil Picq, a young aeronaut, lately deceased, and is intended to save ballast as well as to serve as a parachute in case of accident to the balloon.

It is well known that when the contained gas cools in the higher regions of the atmosphere the balloon descends, and ballast has to be thrown out in larger quantities than those just sufficient to restore the equipoise, for otherwise accelerated velocities would result. The descent once stopped, the balloon immediately rises again, and (the whole system being lighter) to a point generally higher than that previously attained, so that gas has to be let out to compensate for the previous loss of ballast. A balloon journey, therefore, consists of a series of ascents and descents, and alternate losses of ballast and gas until the supply of the former is exhausted.

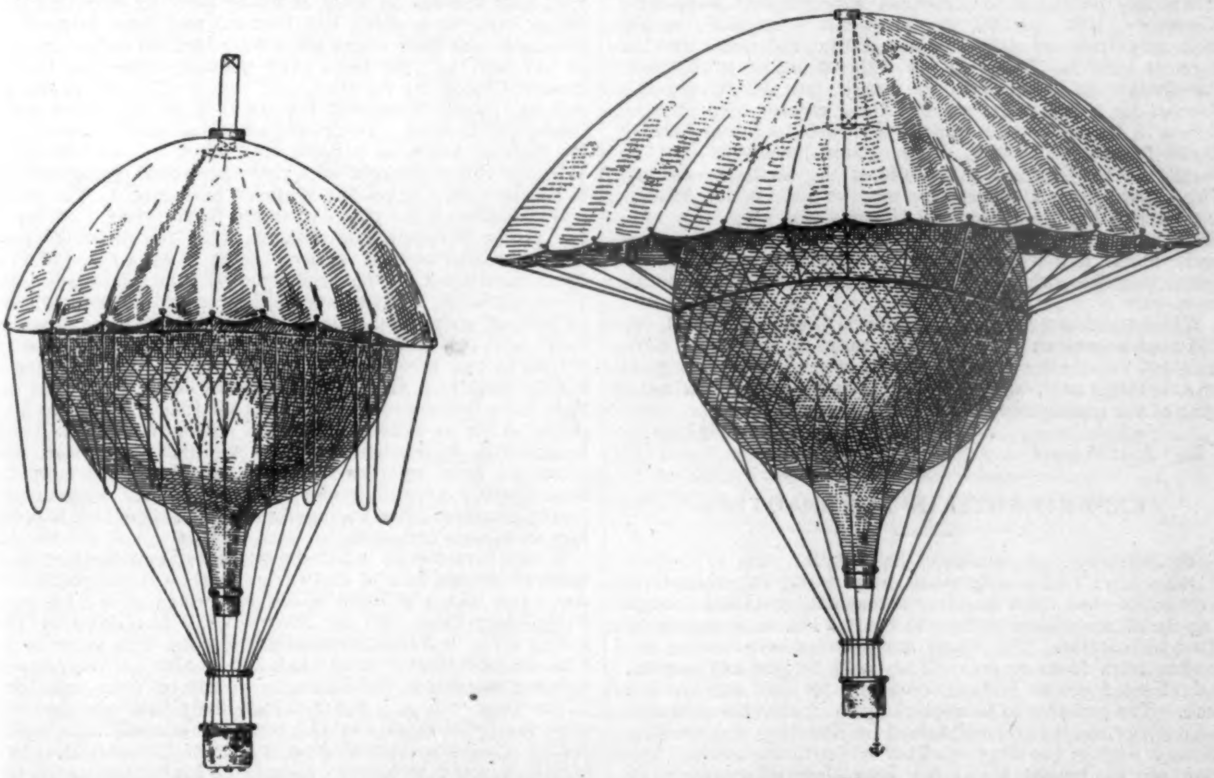


Fig. 1. Fig. 2.

A NEW PARACHUTE.

M. Picq proposed to remedy this partly, and to lengthen the time of the journeys, by applying the parachute above the balloon, as shown in fig. 1, his idea being that if a decided descent sets in, the parachute will open as shown in fig. 2, and by increasing the resistance enable the aeronaut to arrest the downward movement by throwing out a much smaller quantity of ballast than would otherwise be required. A corresponding amount of gas would thus also be saved, and the upward oscillation would be diminished.

Whether in actual practice so limp and flabby a surface as that of the parachute could be relied upon to open and close symmetrically, as shown in the figures, can only be told by actual experiment.

THE VALUE OF METEOROLOGICAL OBSERVATIONS AT HIGH ALTITUDES.

DIMINUTION OF TEMPERATURE WITH ALTITUDE.

To the Editor of THE AMERICAN ENGINEER:

There have been few questions in meteorology of so great importance as this of the distribution of heat in a vertical direction in our atmosphere. There is very little doubt that the hot wave ushering in a storm at the earth's surface is of cosmical origin, and extends to the limits of our atmosphere. Precisely the same is true in the case of our cold waves. A great deal of misapprehension has arisen from considering that the front of these hot and cold waves is nearly vertical, while records on Mount Washington, Pike's Peak, and other mountains have shown that these conditions are far ahead in the upper air. At Mount Washington they are 24 hours ahead, although a part of this is due to a slightly greater insolation after the hot wave has begun at the earth and a greater heat radiation after the cold wave has begun.

A very careful study of records near the earth has established the law of diminution up to 1,000 ft., and now that accurate balloon observations are being greatly multiplied, we may hope to learn a great deal in regard to temperature conditions up to heights of 12 or 15 miles. The enterprise of Dr. A. Berson, in taking up a cylinder of oxygen and, by the inhalation of the gas, in reaching a height of 28,700 ft., marks an era in atmospheric exploration, and we may now expect an accurate determination of temperature, humidity, air currents, etc., at heights of 7 miles.

It should be remarked that weather conditions are so moderate in Europe and the motion of storms is so slight there that we cannot hope for an elucidation of the forces causing normal and extreme storms in this country by any number of records abroad. Storms or low-pressure areas in Europe have very slight intensity, the gradients of pressure are extremely small, and the motion of the low areas very erratic. This fact accounts for the greatly reduced velocity of low areas in Europe, only about half the velocity experienced in this country. High areas often remain stationary for more than

two weeks, and the pressure in these is very often much greater than ever noted in America. We may best call these conditions stagnant, and to such an extent is this true that the weather runs in types, a certain type of pressure distribution betokening a certain character of weather for a week or more. It is needless to remark that nothing of this kind is known here.

All this, however, does not detract from the greatest interest attaching to these efforts abroad. It has been shown already that the air currents up to 10 miles have very nearly the velocity of similar currents in this country, and this would seem to emphatically disprove the views of many who think that our storms are merely columns of heated air drifting in the upper current, and also of those others who imagine that our storms are whirls or eddies formed in a poleward moving upper current.

It has been well established that in clear weather the temperature, especially in winter and when there is little or no wind, rises in the early morning up to about 300 ft. The reason for this is very clear: intense radiation through a clear, still air cools the earth enormously, and this cooling affects the air immediately above the earth. Beyond 300 ft. there is generally a pretty uniform diminution of temperature, with altitude probably one-third greater in summer than in winter in the eastern and northern United States. This diminution is seldom greater than 1° in 250 ft., or less than 1° in 400 ft.

In cloudy weather, however, the temperature is either nearly uniform up to the clouds, or it may rise a little as we approach them. In the cloud itself, as we come into the sunshine, the temperature rises very rapidly, due to the intense heat of the sun upon the cloud. These principles are so simple and plain, that it is a matter of wonder that any one should be misled by any observations of this nature in balloons. In a balloon voyage at Providence, R. I., an account of which is published in *American Meteorological Journal* for November, 1891, p. 292, the temperature remained nearly stationary up to the cloud region 1,000 ft., and rose over 7° in the next 1,300 ft. From the top of the clouds up to 10,000 ft. the diminution in temperature was 1° per 409 ft. In this *Journal* for March there are given the records made by Dr. Berson in his memorable voyage in which he reached nearly 29,000 ft. In the descent, at the cloud level (4,600 ft.), he found the temperature 43°, while at the earth it was 34°. This experience was almost precisely the same as the previous one, except that the diminution in temperature was only 1° in 249 ft. above the cloud region. Dr. Berson's ascension was made about half-way between a "high" and "low," but nearer the latter, which will account for a part of this difference.

While there are certain fundamental laws established, we still need numerous records in the centre of storms and high areas and on all sides of them. Almost every ascension gives us something new, and we may hope before long to settle some of the questions which are so doubtful now.

H. A. Hazen.

May 4, 1895.

EXPERIMENTS IN AERONAUTICS.

To the Editor of The American Engineer:

Dear Sir: I have progressed so far in my experiments in aeronautics that I am building a machine that will contain 1 sq. ft. of sustaining surface to every 2 lbs. of weight to be lifted and carried. The wings are to be concavo-convex, and flexible from front to rear. They will be long and narrow, and vibrated on an incline down and forward and up and back. The power is to be applied by the feet of the operator, and equilibrium is to be maintained by elevating or depressing the back edge of the wing on either side with the hands. One wing can be depressed and the other elevated or *vice versa*, each wing independently of the other, to guide to the right or left, or they can be elevated or depressed simultaneously to steer up or down. To get the first start, I propose to elevate the machine on a tripod—the wings and tail might be made to act as the tripod—and then climb up to it by means of a rope ladder, then to fall down and forward, carrying the machine and tripod with me. The top of the tripod will act as a lever to throw me forward and down. While falling I propose to vibrate the wings with my feet, and guide or steer with my hands on a lever connected with the back part of the wings. Somebody may smile at this, but in the future I will endeavor to prove what I say. There are so many good people who *will* smile at an investigator in this branch of science, because it is funny to see a man dangling from a machine up in the air trying to do what almost everybody considers impossible. I find it hard work to keep myself in hiding, for a machine to fly has to be in the air, and when it is in the air it is in a position to be viewed by everybody in sight. It requires a good deal of nerve to go ahead under all and every condition of circumstances. In order to propel, I propose to carry my weight on the wings from a point up and back to a point down and forward. This carrying of the weight from back forward will assist in propelling; then the flexibility of the wings will also assist in propelling. In the return or up-stroke of the wing it will encounter some resistance from the air, striking its upper surface, which will also help to propel, but the most propelling force will result from the dropping of the front part of the machine during the up-stroke, and a consequent tilting up of the tail end, which will make us slide forward and down an incline; then the down-stroke of the wing will again elevate the front end, and the process of again falling and sliding down an incline forward will be repeated. Now can we lift ourself higher in the down-stroke than we will fall during the up-stroke? I say we can, because the wing encounters greater resistance due to our advancing against the air, and in the up-stroke we are still getting an uplift, although the wings are moving up and away from the advancing air. Again, in the down-stroke our momentum, due to our advancing, will more than overcome the horizontal resistance which the wings, body, etc., will encounter in moving through the air. There will be more power required in the start than after we have sufficient head resistance to sustain us. I say head resistance, because that is just what we want and must have before we can ever hope to be lifted in the air. The wings must incline 20° to 35° to advance in order to get this resistance. I have read so often that the various birds require a velocity of 30 to 60 miles an hour to sustain them in the air, but I haven't seen anywhere the statement, which is also true, that these same birds start from a state of rest and *begin* to fly at velocities of 1, 3, 5, or 7 miles an hour, and they do it by vibrating their wings from back down and forward and from forward up and back, and their wings are always inclined to the direction of advance—*i.e.*, the front edge pointing above the horizon from 20° to 45° at the start, to 1°, 2°, or 3° in full flight, except in upward currents of the air, then the front edge points below the horizon. Their wings are inclined to advance at the start as much as a boy's kite when he starts to fly it. What would be thought of a boy who would persistently try to elevate a kite by holding it almost horizontal? Yet we are trying to elevate a flying apparatus by so doing. Of course less power is required to advance when the plane is nearly horizontal, but how are we ever going to get a speed of 30 to 60 miles an hour on the ground unless it be a railroad-track? We must begin to fly at speeds, like a bird, of 3 to 10 miles an hour or give it up, and leave the problem to be solved by those who can afford to build a smooth track, and who are willing to run the risk of a broken neck in coming back to mother earth at a 40-mile rate. A man can exert from 1 to 2 H.P. for a few seconds, and this is all that is needed to get a start. After he is once going, the power required will only be one-fifth to one-tenth of that required at the start, and when we have up-currents of air, which is invariably the case, soaring or sailing can be accomplished without any power whatever from the operator, save that which is necessary to balance and steer.

If each investigator in this department of engineering would make public his mite of knowledge on the subject, there is no doubt but that a solution would be arrived at in a comparatively short time. On the other hand, a man don't feel like giving away information which has taken him years to get without protection of some kind, and I think our Government makes a mistake in not issuing a patent on flying machines unless they "*do go*," for it is not likely that one man will solve the problem as a whole, but each one will have a part, and he should be able to protect himself in that part. As it is he is disposed to keep to himself all his attainments in this branch of science, and the world at large laughs at the individual, but I think if these individuals could make known to each other their separate ideas and inventions, the laugh would be on the other side.

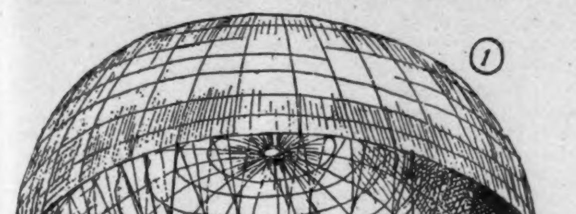
Charles Zimmerman, M.D.

Frederick, Md., May 3, 1895.

A GUIDABLE PARACHUTE.

Mr. Copazza, a French aeronaut, has for the past year been experimenting with a new dirigible parachute of his invention. This is placed above the balloon, the latter being so shaped as to be enclosed by the suspending lines which connect the parachute with the car. Upon attaining the desired height the balloon is torn open and collapsed, the envelope

falling down to the hoop, as shown on the engraving (fig. 1), and the expanded parachute then coming into action. A rope is attached to each of the two extremities of two rectangular diameters, by three different smaller lines, thus giving command (by passing each main rope round two pulleys fixed, as shown in fig. 3) of four rectangular directions, by drawing on the corresponding line and thus shifting the centre of gravity. This is considered an improvement upon the current practice of some aeronauts who climb on the edge of



A GUIDABLE PARACHUTE.

their car, as shown on fig. 2, in order to send their apparatus sideways to clear an obstruction.

Mr. Copazza has made some experiments by collapsing his balloon at a height of about 3,000 ft., and has descended in safety with a moderate success in directing his course. He is to experiment again this summer.

THE UNITED STATES SENATE ON AERIAL NAVIGATION.

On December 20, 1893, Senator Cockrell introduced a bill in the Senate of the United States providing

"That the Secretary of the Treasury is hereby authorized and directed to pay the sum of one hundred thousand dollars to any inventor, from whatever part of the world, who shall, at any time prior to the first day of January, A.D. nineteen hundred, construct a vessel that will, on the verified report of three engineers appointed by the Secretary of War, demonstrate, within or near the city of Washington, the practicability of safely navigating the air at a speed of not less than thirty miles an hour, and capable of carrying passengers and freight weighing a total of at least five tons."

Somewhat similar bills have been introduced in Congress before, generally in the interest of some inventor who thought that he had solved the problem of aerial navigation and wanted a chance of demonstrating it, but they have heretofore been laughed down or ignored. The remarkable thing about this last bill is that it was soberly considered, and that a special report thereon was made February 25, 1895, by the Committee on Interstate Commerce, through its chairman, Senator Brice.

This report (No. 992, Calendar No. 1,063) consists of 13 printed pages, and reviews the "state of the art" as made known by recent improvements and publications. It draws the line between *aeronauts* who believe that success is to come through some form of balloon and *aviators* who believe that the successful apparatus must be heavier than the air, and somewhat like a large sailing bird with pinions extended, and it discusses the advance made in recent years with each class of apparatus.

After describing what has been accomplished by the French with balloons, the report quotes from the opening address of Mr. Chanute to the Conference on Aerial Navigation in Chicago in 1893, concerning the present status of navigable balloons, and also gives extracts from a letter to Mr. Gilliland written in May, 1894, by Mr. Chanute, whose conclusion is that: "Should the proposed bill become a law, its conditions would probably be complied with, and possibly by more than one inventor. . . . Such a craft, however, would necessarily be frail, and liable to many accidents after the first trials had demonstrated its speed and carrying capacity. It would doubtless prove efficient for war purposes, where risks must be taken, but could not compete with other modes of transportation in time of peace."

Then follows a memorandum prepared by Captain W. A. Glassford, of the United States Signal Corps, who superintended the construction and equipment in France of the United States signal balloon *General Myer*, stating that such light as has emerged, notwithstanding the profound secrecy maintained about French war balloons, indicates that for 81 days out of 100 the conditions of wind in France will permit of the use of such balloons, and saying: "This, considering the taking advantage of the velocity of favoring winds, is equivalent to a speed of 28 miles an hour in calm air, and therefore nearly attains to a satisfaction of the speed requirements of the bill."

The report then discusses the recent advance in attempts at aviation. It describes the gliding flights of Lilienthal, quotes from the writings of Professor Langley, Mr. Maxim, Mr. I. P. Holland, Mr. Eddy, Mr. C. W. Hastings, and Mr. J. B. Walker, and gives an account of the flight of Mr. Maxim's apparatus in England on July 31, 1894.

The Committee's final conclusion is:

"Owing, however, to the recent and still continuing deficiency in revenues to meet ordinary appropriations, and the condition of the Treasury, as shown by the several recent issues of United States bonds, your committee do not at present recommend the passage of this bill, but report the same without recommendation."

This report, although somewhat inconclusive, marks a new era in the public appreciation of the subject. It removes aerial navigation from the domain of vagary and recognizes that we are now within a measurable distance of success. It seems probable therefrom that the wise thing for the United States Government to do is to experiment with navigable war balloons, as the English, French, German, Russian, Austrian, Italian, Spanish, Belgian, and Holland governments have done, and to await some important advance in securing safety with aviating machines before undertaking to avail of the higher speeds to be expected with this class of apparatus.

Transit in Air.—Those who have written or experimented on the subject of aerial flight speak of a difference of effect with the wind and against it, and assume that power is lost in one case and gained in the other. Of course, if any form of flying machine is raised against the wind, at the first moment of starting it is impelled with a force equal to the velocity of the wind; but this is only a momentary effect due to the inertia from the weight of the machine, which soon becomes exhausted, and then the machine must finally partake of the velocity of the wind itself.

So prevalent has been this misunderstanding, that it has been asserted that a bird may acquire velocity by first going with the wind, and, with some velocity and momentum thus acquired, turn suddenly against it, and so gain an almost continuous raising power. But the fact is, the velocity in the tidal body of air is the same in all directions, and the force required for flight similar. A bird may be using up its utmost strength to fly at the rate of 40 miles per hour against a 40-mile breeze, and so appear to be stationary to observers on the earth below; but if the bird flies in the opposite direction, it will speed at the rate of 80 miles per hour relative to the earth, but the actual force and speed of flight *through the air* will be the same in both cases.

If the flying machine be launched from a balloon with the earth hidden from view by intervening clouds, there would be no means of ascertaining which way the wind was blowing relative to the earth, for a balloon is a perfectly stationary

machine floating in a body of air, and the flying machine, uninfluenced by the earth, might go off in any direction under precisely equal conditions, its real rate of progress being through the air only, and not to be measured by any reference to the earth below, of the existence of which the aeronaut may be as unconscious as if blindfold. It is like a ship that may be carried many miles out of her course by an ocean current, and of which the navigators may have been quite ignorant till their true position is detected by celestial observation.—*F. H. Wenham, in the English Mechanics.*

The Motion of Clouds.—In a recent number *Science* gives an abstract of a lecture on this subject delivered by Mr. W. N. Shaw, F.R.S., before the Royal Meteorological Society of London, on The Motion of Clouds Considered with Reference to their Mode of Formation.

The question proposed for consideration was how far the apparent motion of a cloud was a satisfactory indication of the motion of the air in which the cloud is formed. The mountain cloud cap was cited as an instance of a stationary cloud formed in air moving sometimes with great rapidity; ground fog, thunder clouds and cumulus clouds were also referred to in this connection. The two causes of formation of cloud were next considered—viz. (1) the mixing of masses of air at different temperatures, and (2) the dynamical cooling of air by the reduction of its pressure without supplying heat from the outside. The two methods of formation were illustrated by experiments.

A sketch of the supposed motion of air near the centre of a cyclone showed the probability of the clouds formed by the mixing of air being carried along with the air after they formed, while when cloud is being formed by expansion circumstances connected with the formation of drops of water on the nuclei to be found in the air, and the maintenance of the particles in a state of suspension, make it probable that the apparent motion of such a cloud is a bad indication of the motion of the air. After describing some special cases, Mr. Shaw referred to the meteorological effects of the thermal disturbance which must be introduced by the condensation of water vapor, and he attributed the atmospheric disturbances accompanying tropical rains to this cause. The difference in the character of nuclei for the deposit of water drops was also pointed out and illustrated by the exhibition of colored halos formed under special conditions when the drops were sufficiently uniform in size.

A HELIOGRAPH MESSAGE FROM BRITISH COLUMBIA TO MEXICO.

A copy of the following circular has been received by us, which will explain itself:

PORTLAND, OREGON.

To the Editor of AERONAUTICS:

"Mazamas" is the name of a society of mountain climbers. It was organized on the summit of Mount Hood, Ore., on July 19, 1894, at which time and place the constitution and by-laws were adopted and first officers elected. Its organization was unique and successful. The experience of its members on that occasion inspires them to further achievements. The mountains furnish delight and inspiration which no man or woman can know or dream save those who have attained "exaltation" on the heights. There's health, joy and freedom there.

This year their aspiration is to convey by means of heliographs along the line of snow-capped peaks a sunbeam message from British Columbia to Mexico. Washington, Oregon, and California are invited to co-operate and carry out this plan.

The principal mountains in Oregon and Washington available for the purpose, beginning at the north, are: Baker, Rainier, St. Helens, Adams, Hood, Jefferson, Three Sisters, Diamond Peak, Thielsen, Scott and Pitt, and in California Mounts Shasta, Tellac, Round-Top, Dana, Lyell, Stillman, Whitney, Lowe, Baldy, and such other peaks as are necessary to complete the chain.

Citizens residing in the vicinity of the various mountains available for the purposes above suggested are besought to "take a hand" and aid the attempt. Arrangements can be made so that parties on sub-peaks, or in the valleys and towns along the line can communicate with those on their main mountains, and each group of mountaineers can, from their several signal stations, "telegraph," by flashes, to their neighbors below the fact of their presence on the peaks, and also the fact that the "message" from British Columbia is on its way and of the transmission of the answer from Mexico.

The intention is to send a message from British Columbia to Mexico and transmit an answer from Mexico to British Columbia, and as each message passes a signal peak, such signal peak is to report the fact to all such sub-stations, and groups in valleys and towns in their vicinity, as are prepared to receive it.

Storms may obscure some main peaks, so numerous side stations, or sub-peaks, are desirable to secure transmission of the through message.

The instrument to be used is the modern heliograph, such as is in use in the regular army, operating the "Morse Code."

Heliograph instruments can be obtained or prepared at comparatively small expense. The secretary will, on application, furnish addresses of regular manufacturers, and information for making suitable instruments sufficient for the purpose.

The date fixed for this event is July 10, 1895.

The main body of Mazamas as a society will assemble at Mount Adams in the State of Washington.

Correspondence is being opened and desired with all outing clubs, athletic, mountain, military, university and scientific organizations on the coast.

The Government officers and various State military organizations and officers are invited to arrange details from the signal corps "to aid the grand design."

Each party is requested to arrange for procuring photographic views of their several "camps" and principal points of interest, particularly of the group of climbers on the peaks attained.

Correspondence is solicited, and information will be supplied by the society.

W. G. STEEL, *President*,
MISS MAY FULLER, *Vice-President*,
L. L. HAWKINS, *Treasurer*,
M. W. GORMAN,
REV. ROLAND D. GRANT,
J. FRANCIS DRAKE,
} *Executive Council.*

Address all communications to

T. BROOK WHITE,
Secretary.

14 Worcester Block.

RECENT AERONAUTICAL PUBLICATIONS.

Gaston Tissandier the Balloonist. R. H. Sherard. *McClure's Magazine*, May, 1895. An interesting account of Mr. Tissandier's aeronautical work and opinions as to the future.

Wind Pressures in Engineering Construction. W. H. Bixby. *Engineering News*, March 14, 1895. An exhaustive review of publications and experiments on wind pressures and formulæ, and their application to structures.

Aerial Mechanical Flight. C. H. Mitchell. *Engineering Society of School of Practical Science. Toronto University*, February 20, 1895. A paper reviewing recent publications on aeronautical subjects, and formulating some of the principles which have been established.

Report on Aerial Navigation. Senator Brice. *United States Senate Publication*, February 25, 1895. The Committee on Interstate Commerce reports, without recommendation, on a bill (§ 1,344) which proposed to offer a prize of $100,000 for a navigable air-ship, and reviews the recent advances toward a solution of the problem.

Recent Experiments on Wind Pressures. J. Irminger. *Engineering News*, February 14, 1895.

Mr. O. J. Marstrand gives an abstract of the experiments of Mr. Irminger, of Denmark, concerning the pressure and rarefaction of air currents on different sides of plates and bodies inclined at various angles. It is shown that at small angles of incidence—0° to 5°—the wind blowing over a surface produces nothing but suction; this action throwing additional light upon the phenomenon of "aspiration."

Le Siège de Paris, vu à Vol d'oiseau. W. de Fonvielle. J. Hetzel & Co., publishers, Paris. 285 pp. Mr. de Fonvielle, the veteran aeronaut and author, has published a further account of the balloon ascents and journeys which took place during the siege of Paris in 1870. The book abounds with personal reminiscences, and incidentally throws a good deal of light upon the state of mind of the Parisians during this memorable siege. The author confines himself to relating the phases of some of the voyages, having already treated the technical part of the subject in his "Manuel pratique de l'Aéronaute."

AMERICAN ENGINEER AND RAILROAD JOURNAL.
(Formerly the RAILROAD AND ENGINEERING JOURNAL.)

PUBLISHERS' DEPARTMENT.

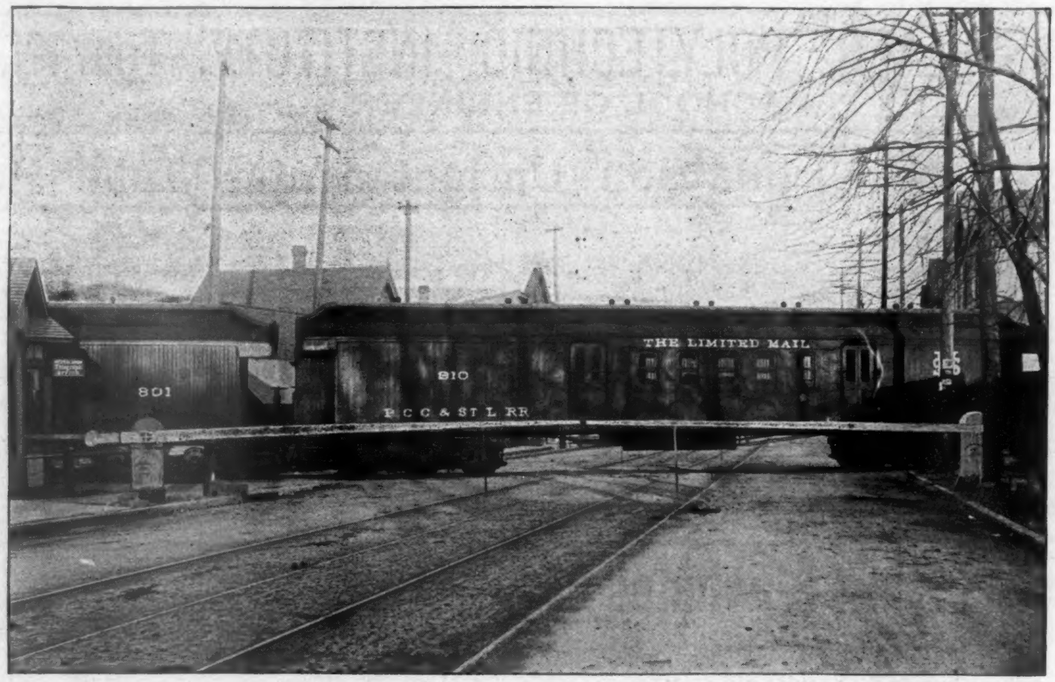
THE DAYTON RAILWAY-CROSSING GATE.

THE engraving herewith represents a railway-crossing gate, which is manufactured by the Craig-Reynolds Foundry Company, of Dayton, O., and which is described as follows by a representative of that Company:

"Among the many appliances which inventive genius has devised in aid of safe and efficient railway service, none have received more generous welcome and won the appreciative recognition of railway men, than the Dayton Railway-Crossing Gate, manufactured and erected by the Craig-Reynolds Foundry Company, of Dayton, O. In these days of agitation by many cities over the elevation of tracks and its attendant expenses, involving many millions of dollars, the subject of proper protection of crossings in cities and towns, that they may be rendered absolutely safe against accidents, is receiving the attention of our best engineering talent, and has brought about the consideration and adoption of safety crossing-gates, that dangerous crossings might be thoroughly protected at a comparatively small expense, thereby silencing public clamor for the elevation of tracks, preserving the safety of many lives and property, and the prevention of damage suits, which are the natural result of accidents occurring at unprotected crossings.

"The Dayton Gate is a radical departure in construction and mode of operation from the old style chain or air gates with their attendant difficulties and expense. In actual service upon many of the prominent railway systems, it has elicited pronounced commendations upon its advantages in method of operation, construction and durability during all seasons of the year and under all climatic changes. The working parts of the gate are simple in construction, direct-acting, and without intricate mechanism and the attendant difficulties. The underground connections are arranged to prevent entrance of moisture in any form, thereby obviating a serious defect found in other modes of construction. A distinctive point of merit, which appeals to railroad companies, is that two or more gates can be operated from one tower-house by one operator, thereby doing away with an extra flagman and the additional expense. At Mattoon, Ill., this Company has recently erected two sets of gates for the Big Four system, each 1,200 ft. apart, and handled by one operator with perfect ease and safety.

"Among the roads recently purchasing the gate are the Pennsylvania Company, the Southern Pacific, the San Antonia & Aransas Pass, and the Western New York & Pennsylvania Company."



A DAYTON RAILWAY-CROSSING GATE, ERECTED FOR PENNSYLVANIA CO., THIRD STREET, DAYTON, OHIO.

General Notes.

The Consolidated Car Heating Company call attention to the changes and announcements that they have made in their advertisement in this issue.

The American Institute of Electrical Engineers have removed the office of the society from 12 West Thirty-first Street to rooms 1,009 and 1,010 Havemeyer Building, 26 Cortlandt Street, New York City.

Queen & Co., of Philadelphia, announce that there is an excellent prospect of a speedy adjustment of their affairs. Meanwhile their large stock is kept up and orders are being filled as usual. Very great reductions have been temporarily made in their prices.

The George F. Blake Manufacturing Company has received the contract for an improved high-duty pumping engine for the Honolulu Water Works. It is the high-speed type, with automatic cut-off, and is now in course of erection at their East Cambridge works.

M. T. Davidson, Brooklyn, N. Y., with New York headquarters at 77 Liberty Street, has recently filled some big orders for Davidson pumping engines. One for the water-works of the city of Chelsea, Mass., is a splendid piece of work, as is also a pumping engine of similar magnitude and design for the water-works at Fall River, same State. A large order from a prominent phosphate company in Florida consisted of the entire equipment of its steam plant, including boilers, pumps, etc.

The Armstrong Manufacturing Company, of Bridgeport, Conn., have one of the largest and most complete plants of its kind in the United States. This concern manufactures an extensive line of water, gas and steam-fitter's tools of uniformly high grade and noted for their time and labor-saving qualities. The improved pipe threading and cutting-off machines, for hand and power, made by the company are especially popu-

WM. A. ROSENBAUM,

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lar, and there has been a steady demand for them during the last year.

The Finlayson Boiler Company, Limited, of Detroit, Mich., although in the field but a little over a year, have already in operation a considerable number of their upright water-tube boilers, and are meeting with a steadily increasing demand. The results attained in their boilers appear from reports to be highly satisfactory. We understand that they recently supplied a 150-H.P. boiler to the canal steamer *Maher & Burne*, of Buffalo. Their boiler possesses many new and valuable improvements that are worthy of investigation. Their advertisement is on page xix of this number.

Michigan Engineering Society.—The Secretary has sent out the notice that the next annual convention will be held at the Hotel Downey, in Lansing, Mich., on January 15, 16 and 17. The following is a partial list of the papers that will be presented: Rights to Land by Possession, by Judge F. A. Hooker, of the Supreme Court; Difference in Magnetic Needles, by Messrs. Gurley, Buff & Berger and L Beckmann; Masonry of the Lock in the "Soo" Canal, by J. L. Callard, of the U. S. Engineers; Old Surveys of Detroit, by Thomas Campau, Detroit; Street Railway Construction, by R. W. Roberts, City Engineer, Saginaw; Water Waste, by G. S. Williams, Superintendent of Water Works, Detroit; Tunnelling for Sewers, by Albro Gardner, Seattle, Wash.; Some Details of Sewer Construction, by F. F. Rogers, City Engineer, Port Huron; Special Assessments, by M. C. Taft, City Engineer, Kalamazoo; Grand Rapids Plaster Quarries, by C. H. Redman, Grand Rapids; Grades for Highways, by John Randall, Mio; Transmission of Power, by E. Dennis, Jackson; Highway Bridges in Manufacturers' Hands, by Professor H. K. Vedder, Agricultural College; Field Work of Surveys in Marquette County, by Charles Cummings, Marquette; Tests of Blasting Powders, by H. Melchers, Saginaw; Mineral Resources of Northern Arkansas, by E. L. Hayes. Other papers are expected from J. J. Granville, of Saginaw; William G. Fargo, of Jackson; Professor C. E. Greene, of Ann Arbor, and others on subjects not yet announced.

Leather Belts.—No one using leather belts can afford to be indifferent to their care. There is a certain amount of elasticity in all good leather belting, but time and continued hard work seem to destroy or at least weaken its power. Then comes the question whether it is better to simply tighten the belt or use some form of dressing. Experience of many very practical observers seems to favor the use of a good dressing, as tightening the belt strains it and calls for more engine power. A dynamo engineer who is transmitting 60–65 H.P. with a 50-ft. link belt 8 in. wide, running from a 72-in. pulley on driving shaft to a 18-in. pulley on dynamo, claims that freedom from jumping and flickering of the lights is due entirely to the belt dressing used, and that tightening never helped. The superintendent of a large printing establishment has an 18-in. main belt now running its eighth year which has never been taken up, and it would be extremely hard to convince him that the dressing used does not preserve the life of the leather and keep it soft and elastic. Of course one should be careful what sort of dressing is used. Soap, resin, tar and tallow should not be used at all. Even castor oil is criticised. The dressing used in the two cases cited was Dixon's belt dressing and leather preservative, which was the only article that would start the big driving belt used at the Paris Exposition in 1878, and keep it from slipping. Circulars about the dressing will be sent to any one interested by the Dixon Crucible Company, Jersey City, N. J.

Correspondence Schools.—We mentioned last month the receipt of a number of publications relating to the "correspondence schools" at Scranton, Pa.; among these, and of most interest, are a large number of letters—nearly two hundred—written by students in respect to their experience and opinions of the system. It is the most original agency for technical education that has ever been devised, capable of an extension that has no visible limit, and portends a time when we will not set off a few of the most fortunate for education, but educate all up to the limits required in the application of the skilled arts. One effect will be to raise the standard of the ordinary courses in technical colleges and schools because mediocrity can be attained at a tithe of the expense and in ways more congenial to most students.

The habit of writing out exercises is a good one, good in all kinds of mnemonic effort, and when to this is added the interest of a communication personally addressed and the environment of a home it is easy to discern the attraction of a correspondence system.

Among the papers mentioned is one sheet of examples in hydraulics that as a collection of educational problems is the best we have ever seen. When a set school book is done and the plates made there is an end, but in the present system a tentative course is possible. Change and improvement can go on continually; not only this, the problems submitted can be nicely graded to the requirement and capacity of the student, and can, by the facility for change, be made relevant to the particular examples or practice.—*Industry.*

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A MUCH-NEEDED want has been supplied by this popular line from Indianapolis. Train leaves at 7.30 A.M., arriving in Chicago at 12.59 P.M., returning at 4.58 P.M., reaching the former city at 11.00 P.M. This in addition to its previous excellent service places it ahead of all competitors.

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These trains are vestibuled and electric lighted with the finest dining and sleeping-car service in the world.

The electric reading light in each berth is the successful novelty of this progressive age, and is highly appreciated by all regular patrons of this line. We wish others to know its merits, as the Chicago, Milwaukee & St. Paul Railway is the only line in the West enjoying the exclusive use of this patent.

For further information apply to nearest coupon ticket agent, or address George H. Heafford, General Passenger Agent, Chicago, Ill.

OURSELVES AS OTHERS SEE US.

THE *Herald*, of Glasgow, Scotland, speaking of the "Four-Track Series"—the New York Central's guide-books—says:

"No effort is made in this country to produce railway guide-books that can compete with this series. The scope of the books gives every opportunity for the display of the varied charms of American scenery, there being views on the Hudson River, in the Adirondack Mountains and Catskills, on the St. Lawrence, Niagara Falls, etc. The great feature of the guides is the admirable pictures."

A copy of the illustrated catalogue containing a thorough review of the "Four-Track Series"—books, maps and etchings—will be sent free by mail, postpaid, to any address in the world, by George H. Daniels, General Passenger Agent, New York Central & Hudson River Railroad, Grand Central Station, New York.

AMERICAN ENGINEER AND RAILROAD JOURNAL.
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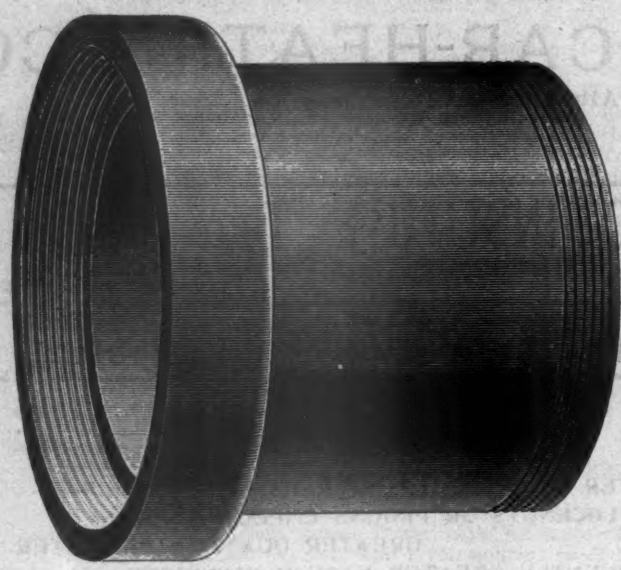
PUBLISHERS' DEPARTMENT.

THIRTY-INCH VITRIFIED SEWER PIPE.

MESSRS. BLACKMER & POST, of St. Louis, call attention by a circular to their 30-in. vitrified sewer pipe, of which they are making a specialty, and are furnishing, to take the place of brick sewers. The internal diameter of these pipes is 30 in.; net length, 2 ft. 6 in.; thickness of shell, 2 in.; depth of socket, which is corrugated, 5 in.; and weight, 550 lbs., or 220 lbs. per foot. Of this pipe they say:



THIRTY-INCH VITRIFIED SEWER PIPE.

"Many engineers with whom we have had correspondence agree with us that the pipe is much to be preferred to brick on account of its smooth surface, and consequently greatly reduced frictional resistance; because of its convenience in laying, whereby the sewer may be constructed very rapidly, and because less excavation is required for pipe than for a brick sewer of the same size, and they have expressed their intention to use our 30-in. pipe wherever practicable in place of brick sewers of about the same capacity provided the cost of the pipe sewer is not too great. In regard to this, we believe that at the low price we are asking for this pipe and branches, it can be shipped to any point where the freight is not more than 20 cents per 100 lbs. and laid in place, complete, with Y branches, at a cost very little, if any, more than a well-constructed two-ring 30-in. brick sewer, while the pipe sewer, with its smoothly glazed surface, would have considerably greater actual capacity."

They have sold over 5000 ft. of this pipe for city sewers, and several thousand feet in smaller lots to railroad companies and others. They ask for the privilege of submitting prices to those about to put in sewers or drains.

DECISION REFERRING TO PATENTS ON PIPE "UNIONS."

UNITED STATES CIRCUIT COURT OF APPEALS, THIRD CIRCUIT.

THOMAS DEVLIN & CO.
vs.
E. P. PAYNTER AND JOHN K. MOORE.

APPEAL from the Circuit Court of the United States for the Eastern District of Pennsylvania.

Before Acheson, Dallas and Wales, J.J. Acheson, J.

The appellants, who were the defendants below, complain of the decree of the Circuit Court sustaining as valid, and adjudging them to have infringed, the first of letters patent No. 367,725 for improvements in unions for steam-pipes granted August 2d, 1887, to E. P. Paynter, Jr., the inventor, and John K. Moore, his assignee, of a part interest.

The claim in question is in these words:

"1. A union for steam-pipes, comprising a threaded nut or ring, a member having a seat of soft metal with a concave face and an opposing member with a rounded or convex end, substantially as shown and described."

The declared object of the invention is to provide a construction, whereby the joint of the union of steam and other pipes will be made more tight than heretofore, and in which the danger of injury by indentation to the soft metal seat of such union will be avoided. The specification states: "The concavo convex character of the joint prevents the seat from being indented, even if the two members of the coupling should not be exactly aligned, thereby avoiding the difficulties hitherto encountered with the flat soft metal seats and straight ends of unions as heretofore constructed."

The specification describes and shows a union, one of the members of which is provided with an internal seat of soft metal, the face of which is made concave, and the opposing part of the union formed with a convex end, so as to conform to the concavity of the seat, against which it rests, thus making a perfectly tight joint therewith.

A pipe union is a complete and independent contrivance, made and sold by itself, consisting of a head and tail member and a fastening nut or ring drawing the two members closely together. The purpose of the device is to join together the adjacent ends of two sections of pipe through which steam or water or other liquids or gases flow. Such unions are not designed to be fixed or permanent couplings, but they are used where the pipes are to be repeatedly disconnected and again joined; and thus it is intended that the unions shall be taken apart and put together again and again. It is of supreme importance that the union should form and constantly maintain a perfectly tight joint, and it is also very desirable that it should be so constructed as to provide for the non-alignment of the pipes which it connects. These ends are attained by the device of the patent in suit. The patented improvement consists in having one of the two opposing members of the union formed with a concave abutting face and the other with a convex abutting face, one of these meeting faces being composed of soft metal.

The evidence is convincing that this improvement effectively overcomes difficulties incident to and inseparable from all the expedients of this general character previously in use. It meets the practical difficulty arising from want of axial alignment of the two pipes which are to be coupled, and it not only secures complete contact between the meeting faces of the head and tail members, when they are first put together, but permits, without impairing the efficiency of the joint, the repeated use of the same union, as the pipes are disconnected and again united.

We have attentively examined all of the earlier patents and the exhibits illustrative of the prior state of the art, in evidence. To discuss these at length and point out the distinctions between them respectively and the Paynter-Moore device, we deem unnecessary. It is enough to declare that, in our judgment, they do not, taken singly or considered together, anticipate the invention in question. They fail to show a union made in accordance with the patent in suit or possessing its peculiar advantages. We are entirely satisfied with the conclusions of the court below that the first claim of the patent in suit covers a union patentably new and useful.

The difference between the union shown by the patent in suit and the appellants' union are there. In the latter the convex face is on the head member and the concave face is on the tail member, reversing the arrangement of the patent; and in the appellants' union the convex face is composed of soft metal, whereas in the union described in the patent it is the concave face which is of soft metal. The appellants have transposed the position of the soft metal face. Do they escape infringement by this transposition of parts? We think not. The essence of the invention, as embodied in the first claim of the patent, is a union in which one of the two opposing members has a concave abutting face and the other a convex abutting face, one of these faces being of soft metal. The appellants, therefore, *have appropriated the gist of the invention*. The changes found in their devices do not at all effect either the principle of operation or the result. There is a substantial identity between the unions. Now, in the sense of the patent law, the substantial equivalent of a thing is the same as the thing itself. *Winans* v. *Denmead*, 15 Howard, 336, 342; *Machine Co.* v. *Murphy*, 97 U. S. 120. The changes which the appellants have made are immaterial, and, indeed, are but a subterfuge; made, evidently, for the mere purpose of evading the

wording of the claim, they are unavailing. *Hoyt* v. *Horne*, 145 U. S. 302, 304.

Nor do we find anything in the proceedings before the Patent Office requiring us to read the first claim of the patent as subject to the limitations upon which the appellants insist. The reasons urged by the appellants' solicitors before the Patent Office officials in favor of the grant of the patent, if entitled to consideration here at all, do not, we think, regarded as a whole, support the contention that the patentees, when in the Patent Office, placed such a narrow construction upon the claims as would exclude from its scope the appellants' device. We do not see that they take here any position inconsistent with their position when in the Patent Office.

There is nothing to bring this case within the rule that, where a patentee had modified his claim in obedience to the requirements of the Patent Office, he cannot have for it an extended construction which has been rejected by the office.

The only amendment to the first claim ever made was the introduction of the "threaded ring or nut" as an element of the combination, and that addition does not effect the question now before us.

We are of the opinion that the decree of the Circuit Court was right, and accordingly it is affirmed.

FOLSOM SNOW GUARD.

PROBABLY most people have had experience of snow sliding off of a roof, and injuring their hats, their heads and their happiness. The device which is explained in a circular before us is intended to prevent such catastrophes. One form of it consists of a wire loop not unlike in form to a figure 2 or a letter Q, with a long tail. The round part of the loop stands vertically above the roof, and the extended tail has a hook at its extremity, which is driven into the roof under the slate, and holds the loop in its vertical position above the surface of the roof. These are distributed at suitable intervals, and when the snow falls it lodges against these loops and is prevented by them from sliding downward. Another kind is made of sheet metal, in the form of a bracket, the part which extends above the roof being of the form of a letter A. The lower part of the bracket is placed under the slate and secured to the roof-boards. The inventor of this guard says "it is a perfect guard for new roofs, because the snow-stop resists the strain at its strongest part. It is not braced by the slates, and no strain is on the slates, so they cannot be injured."

The Folsom Snow Guard Company, of 33 Lincoln Street, Boston, Mass., are the proprietors of this device.

General Notes.

Westinghouse, Church, Kerr & Co. announce the removal of their New England office from 620 Atlantic Avenue to 53 State Street, Boston.

The Carpenter Steel Company, of Reading, Pa., are now represented in Chicago by Mr. Joseph M. Rogan. Their chief product is their air-hardening steel, which has a high reputation and is well recommended for its superior qualities. It is of their own discovery and invention.

The Consolidated Car Heating Company, of Albany, N. Y., announce that they have received the largest electric heating order ever given. The Union Railroad of Providence, R. I., operating 120 miles of road and about 200 cars, has awarded the heating of all of its cars to the Consolidated Company.

Henry L. Leach, of Boston, Mass., has sent us a postal-card containing a list of the shipments of his pneumatic track-sanding apparatus, made in December, 1894. From this statement it appears that he has sent out 43 sets, distributed among the following railroads: Florida Southern, Boston & Albany, Fitchburg, Central Vermont, Chicago & Alton, Southern Pacific, Western New York & Pennsylvania, Norfolk & Western, Memphis & Charleston, Fall Brook, Atlantic Coast Line, Buffalo & Susquehanna, Southern and New York, Ontario & Western.

The Harrisburgh Foundry and Machine Company, of Harrisburgh, Pa., have recently shipped four 11-in. and 17-in. × 14-in. tandem compound Ideal engines with four high-pressure horizontal return tubular boilers 68 in. in diameter and 15 ft. long, equipped with the Wheitmeyer's furnace, to the Trinidad Electric Light & Power Company at Port of Spain, West Indies; they have also finished a complete outfit for electric light plant and steam heating, to include boilers, engines, lighting and heating apparatus for the Soldiers' Orphan School. Another shipment of a 12-in and 20-in. × 14-in. engine with two boilers to the Pensacola Citizens' Electric Light & Power Company, at Pensacola, Fla., has been made. At New Bedford, Mass., they have just installed a tandem compound Ideal engine 17 in. and 28-in. × 18-in. cylinders, with two horizontal high-pressure return tubular boilers 72 in. in diameter and 17½ ft. long. They have also sent a number of direct connecting engines to the following parties: Hotel Jefferson, Richmond, Va.; Castle Square Theater, Boston, Mass.; Belknap Motor Company, Portland, Me.; Hotel Robinson, New York; the Bolkenhaym apartment house, New York; and a 9-in. and 15-in. × 12-in. engine to South Africa; they have also furnished steam plants to the Berwind-White Coal Mining Company, Osceola Mills, Pa.; Commonwealth Hotel, Harrisburgh, Pa., and the Logan House, Altoona, Pa.

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See Advertisement of BOOKS FOR ENGINEERS AND MECHANICS, Page XXI.

AMERICAN ENGINEER AND RAILROAD JOURNAL.
(Formerly the RAILROAD AND ENGINEERING JOURNAL.)

PUBLISHERS' DEPARTMENT.

FOSTER'S NEW PRESSURE REGULATOR AND PUMP GOVERNOR.

THE purpose of a pressure regulator or reducing valve is to take steam or other fluid of a high and generally variable pressure and deliver it to some machine, as a pump, or to other apparatus, such as heating or refrigerating pipes, at a lower and uniform pressure. This regulation is effected by the action of the fluid, which is delivered at the lower pressure on a diaphragm or piston in such a way that the supply is diminished when the pressure on the delivery side is increased, and *vice versa*.

The Foster Engineering Company hold that there are grave objections to the use of pistons, which it is asserted are not sufficiently sensitive owing to their small size, friction and liability to obstruction by dirt or by water of condensation. For these reasons the regulation in their valves is effected by the action of fluid pressure on a diaphragm, *F F* (fig. 1), which, as will be seen, is corrugated in order to give it flexibility. The inlet for steam or other fluid is at *A* and the outlet is at *B* or at *C*, as may be most convenient.

With a diaphragm valve friction is practically eliminated, and the relatively large area of the diaphragm, which is exposed to the delivery pressure, makes it more sensitive to a varying pressure than a piston would be of a smaller size. The principal objection to the use of diaphragms has been that their rapid and sometimes violent vibrations, especially in valves which deliver steam to pumps or high-speed engines, frequently causes them to break, which necessitates the stopping of the engine, which is often a serious matter. In the Foster valve this is guarded against first by an arrangement which lessens the extent of the vibrations of the diaphragm, and next provision for readily replacing it without stopping the engine or pump in case it fails. These features will be explained farther on.

Another serious objection to pressure regulators in which a spring is used to resist the fluid pressure against the diaphragm or piston is that the pressure of a spring is never the same under different degrees of compression, because the tension of the spring increases as it is compressed or extended; consequently with any movement of the valve the pressure on the diaphragm is also changed.

Another difficulty which is encountered is in keeping the valves tight. Piston valves, if made tight at high pressures, are liable to leak under low pressures, and if made tight under the latter conditions they will not work freely under the former. These difficulties, too, the Foster Company think they have overcome in the valve which is illustrated herewith. As shown in fig. 1, the diaphragm *F F* is attached to a central-

bearing *b*, which has a ⌐¬-shaped arm below the diaphragm, shown to the right of the letter *D*. The ends of this arm are connected to the centres of two horizontal levers, one of which is shown below the letter *D*. The outer ends of these levers bear on seats in the valve case, and the inner ends are attached by a pin to the central spindle *G*, attached to the valves *e* and *g*. It will thus be seen that any vertical movement of the diaphragm *F F* will impart more than double the extent of its motion to the spindle *G* and valves *e* and *g*. Consequently the extent of the vibrations of the diaphragm are much less than they would be if it was connected directly to *G*. The diaphragm is depressed by the two toggles *a a*, which are acted upon by the spring *J*, which is compressed by the nut *K*. If this spring acted directly on the diaphragm, as has been explained, any movement of the valve would alter the compression of the spring. In the construction which is shown the

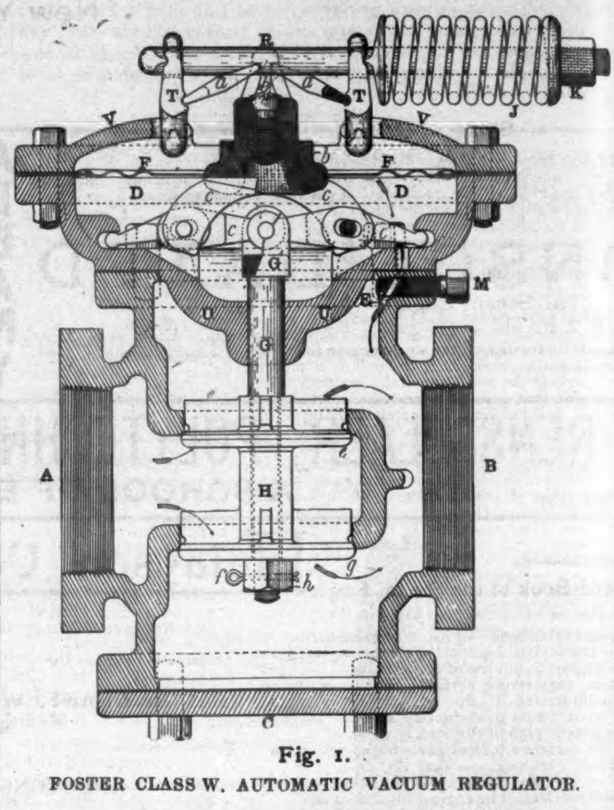


Fig. 1.

FOSTER CLASS W. AUTOMATIC VACUUM REGULATOR.

increased resistance of the spring, as it is compressed, is compensated for by the greater power of the toggles as their inclination is changed by the movement of the valve. By this means the effective power of the spring, as exerted on the diaphragm, remains constant except as it may be changed by the nut *K*.

The action of the valve is as follows: When there is no pressure below the diaphragm the spring *J* presses it downward, which opens the valves *e* and *g*. If, now, steam is admitted at *A* it will flow into the inside of the valve case and by the opening *E* into the chamber *D* below the diaphragm, which will raise it upward a greater or lesser extent in proportion to the pressure of the steam below and that of the spring *J* above it. This will partially close the valves *e* and *g*. As the steam which passes these valves can flow out at *B*, the pressure in the valve chamber will be diminished, and when it reaches a certain point the spring *J* will press the diaphragm downward and thus open the valves more, which will thus admit more

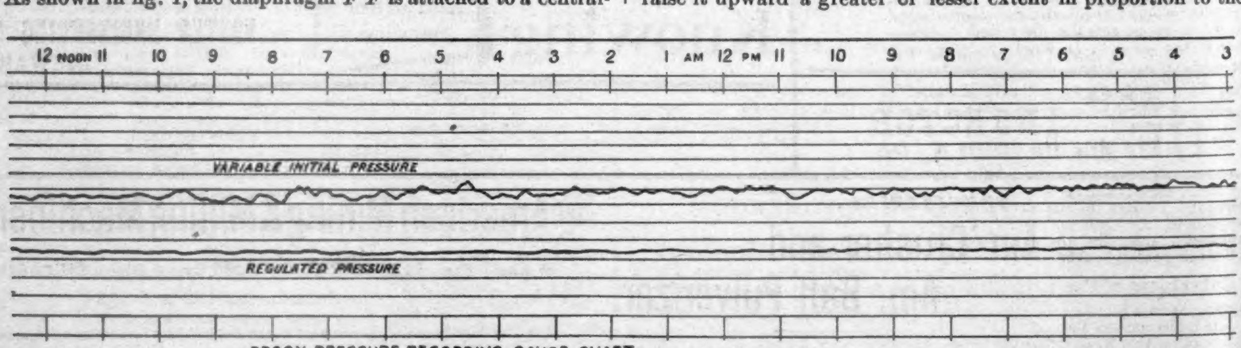


Fig. 2.

CHART SHOWING OPERATION OF THE FOSTER NEW CLASS W. PRESSURE REGULATOR.

Books for Engineers and Mechanics.

The number of books, pamphlets and periodicals on engineering and mechanical subjects in existence, and which is published annually, is now large that no engineer, mechanic or railroad employee can hope to read more than a very small fraction of them, and it is of the utmost importance at such persons should read only the best. Besides the really valuable books which are written by competent persons, who are experts in the subjects out which they have written, there is every year a large number of poor ones published which are written by more or less conceited or stupid incompetents, or by those whose only motive in writing is to make their names known, and such books it is, to a great extent, a waste of time to read and a aste of money to buy. This, "makes it extremely difficult for engineers, mechanics and railroad employees, anxious to keep themselves informed out their business, to know what it is really worth their while to read. They cannot read all that appears, for lack of time, and much of it is not orth reading; yet in the absence of capable criticisms of such works, they cannot easily learn what is really good."

These considerations, and the letters which an editor constantly receives enquiring about books and asking for information about them, has d me to conclude that it might be beneficial to many persons especially to mechanics and others, who have little information concerning the literare relating to their occupations, and that it would be perfectly proper to recommend certain books which deserve recommendation, and give some formation about their value and character. With this in view, the following notices of books have been prepared, and their value and character have en as well indicated as has been possible in such brief descriptions as are here given. These notices represent my own estimate of the character d value of the books to which they refer, and none will be noticed in this list, excepting those which can be recommended to readers, although it ay be with some qualifications, as it is seldom that either books or people are altogether good. M. N. FORNEY.

Steam.

By William Ripper. 5x7½ in. 202 pp. Price, 80 Cents.

This is an elementary book on the steam engine, which written very plainly, withno mathematical obscurities, d is an excellent work to put into the hands of a boy, apprentice, mechanic or other person as an introduction to this anch of engineering. It has the advantage of being brought to a recent date, and is without the usual obsolete descriptions and illustrations often found in books on this subject.

The Steam Engine.

By George C. V. Holmes. 5x7 in. 528 pp. Price, $2.00.

Is a more complete treatise on the steam engine than Ripper's book, and is also of recent date, and well up to modern practice. It is perhaps the best book on the general subject the steam engine that a student, mechanic or young engineer can read. It is not very elaborately illustrated, but has its excellent wood cuts. It contains no mathematics more difficult than algebra, and not much of that. The science of heat and steam is treated in the earlier chapters, the theory of the steam engine follows. These are succeeded by descriptions of the mechanism of engines and boilers, and the concluding chapters are on compound engines. It does not relate especially to stationary, locomotive or marine engines, but the principles and construction of all these are discussed.

A Hand-Book of the Steam Engine.

By Herman Haeder, C. E. 440 pp. 4¾x7 in. Price, $3.00.

The title page of this book—which is translated from the German—says that it has especial reference to small and medium-sized engines for the use of engine makers, mechanical draughtsmen, engineering students, and users of steam power. It is illustrated by over a thousand engravings showing the construction of stationary engines and their details. The general plan of the book is to show the construction of the engines and their parts by engravings and brief descriptions. Its defect is that the descriptions are often not full enough, and do not make the subject to which they relate entirely clear. The engines illustrated are chiefly of German construction, and for that reason, will have very great interest to American mechanics. The book contains little about the theory of the steam engine, and the only mathematics in it, are constructional calculations, and some algebra, but the latter is of a very simple kind, and there is not much of that. In studying the details of construction of small steam engines, this book will be an excellent aid, notwithstanding the defect referred to.

A Practical Treatise on the Steam Engine.

By Arthur Rigg. 379 pp. and 103 full-page plates 8½x11 in. Price, $10.00.

As the author says in his preface, "this treatise was written to describe various examples of fixed or stationary steam engines, without entering into the wide discussion of locomotive or marine practice; to give details of construction, with the principles by which their relative proportions may be calculated, and to investigate the more modern applications of science to the subject. In order to avoid mathematical forms of expressions which are unfamiliar to practical men, the graphic method of calculation is brought into prominent use." The book is probably the best and clearest treatise in the English language in what may be called the dynamics and kinematics of the steam engine, that is on the movement of the valves and their gearing, the action of the cranks, connecting rods and fly-wheels, the theory of governors, the influence of the velocity of reciprocating parts of steam engines and their operation. The chapter on the latter subject forms the clearest elucidation of it to be found anywhere. As stated in the preface most of the topics are explained graphically, the only mathematics in the book is a little elementary algebra.

The Catechism of the Locomotive.

By M. N. Forney. Second Edition. 709 pages 5¾x6 in., and six folded plates. Price, $3.50.

As its name implies, this book is written in the form of questions and answers, and as one of its reviewers said "is written on a low plane;" that is, the subjects to which it refers are explained in the simplest and clearest language that the author could command. As stated in the preface, his object in writing the book "was to furnish a clear and easily understood description of the principles, construction, and operation of the locomotive engine of the present day." There are but two mathematical elucidations in it, and they are in foot notes. It contains nearly 500 engravings which illustrate very fully, different classes of American locomotives and the construction of their parts. The principles and practice involved in these and in the operation of the whole machines are very fully explained, the aim being to make it "plain to plain people." At the same time, the subject was brought fully up to the practice which prevailed when this edition was first brought out, which was in 1889. The book is suited for engineers, mechanics, firemen, students, and, in short, any one who wants information about the principles and construction of the locomotive of the present day.

Compound Locomotives.

By Prof. Arthur Tannatt Woods. Second edition revised and enlarged by David Leonard Barnes. 330 pp. 5¾x8¾ in. 166 engravings. Price, $3.00.

The purpose of this book is to give a description of the theory and construction of the Compound Locomotive in its most recent forms. This is admirably done and in a form so clear that it can be readily understood by any one at all acquainted with the subject of locomotive engineering. It is not an elementary book on the locomotive, but an explanation of compound locomotives for those who are acquainted with the principles and details of simple engines.

The Locomotive Engine and its Development.

Third Edition. By Clement E. Stretton, C. E. Price, $1.00.

The sub-title of Mr. Stretton's book is "A Popular Treatise on the Gradual Improvements made in Railway Engines between the years 1803 and 1892." It is more properly a history of the development of the locomotive. It contains nearly 100 engravings of old and modern locomotives. Mr. Stretton has been an enthusiast in the study of the history of the locomotive, and has rescued from oblivion many facts which otherwise would have been forgotten. To a person interested in the subject, this little book will be as interesting as a novel, as it is written in a very simple style of narration of what the author has learned through his own investigation.

Locomotive Engine Running and Management.

Ninth Edition. By Angus Sinclair. 390 pp. 4⅞x7½ in. 36 engravings. Price, $2.00.

Mr. Sinclair describes his book as "A Treatise on Locomotive Engines, Showing their Performance in Running Different kinds of Trains with Economy and Dispatch; also Directions regarding the Care, Management, and Repairs of Locomotives and all their Connections." The book fulfills this description and also the author's intention, expressed in his preface, "to treat all subjects discussed in such a way that any reader would easily understand every sentence written. No attempt, he says further, "is made to convey instruction in anything beyond elementary problems in mechanical engraving, and all problems brought forward are treated in the simplest manner possible." It is intended primarily for locomotive engineers or runners and firemen, but incidentally will be very useful and instructive to locomotive superintendents, mechanics, and others who want information about the operation of locomotives. The language, explanations and directions are all admirably clear and easily understood.

The Construction of the Modern Locomotive.

By George Hughes. 261 pp. 5½x8¾ in. 309 Figs. 3 folded plates. Price, $3.50.

As its title indicates, and as the author says, "design is not touched upon" in what he has written. "Each section," he says, "describes, step by step, more minutely, and by such drawings and illustrations as have not appeared before in one volume, the actual progress of the work done in that station." The author is an Englishman and describes how an English locomotive is built, or how the work is done in the boiler-shop, iron and brass foundries, the forge and "smithy," coppersmith's work, machine and erecting shops. The methods of doing work is illustrated by engravings from original drawings. American readers will be interested in some of the methods in use in British shops, which differ somewhat from American practice. The book is a good one, but considering what an excellent subject the author had, what he has written and published ought to have been better than it is.

A Manual of Marine Engineering.

By A. E. Seaton. 6x9 in. 459 pages. Price, $6.00.

This is a treatise on the designing, construction and working of marine machinery. The Author says in his preface that it "has been prepared to supply the existing want of a Manual showing the application of theoretical principles to the design and construction of marine machinery, as determined by the experience of leading engineers, and carried out in the most recent successful practice."

It is an elaborate treatise, which is brought up more nearly to the most recent knowledge and practice in marine engineering than any other similar book. It is not very fully illustrated, but has about 100 wood cuts There is a liberal use of mathematics and the reader should be well up in algebra to read it with satisfaction. It treats of the principles of marine propulsion, principles of steam engineering, details of marine engineering, propellers, boilers and miscellaneous matters.

A Treatise on Steam Boilers.

By Robert Wilson. 4½x7 in. 328 pages. Price, $2.50.

This book is by a practical man, and is written so that any one can understand it easily. It has little or no mathematics, and few engravings, but is a very excellent treatise on a subject in the elucidation of which practical experience is of more value than scientific theories.

Boiler Makers' and Engineers' Reference Book.

By Samuel Nicholls. 5x7¾ in. 273 pages. Price, $2.50.

This theoretical and practical Reference Book contains a variety of useful information for employers of labor, firemen and working boiler-makers, iron, copper and tinsmiths, draftsmen, engineers, the general steam-using public, and for the use of science schools and classes. This volume belongs to the "practical" class of technical literature. It is intended for a hand-book for all those who are engaged in the trade of boiler-making. The first 80 pages contain tables and other data which are found in nearly all engineer's pocket books. There are then about 150 pages devoted to the theories and practice of boiler-making. The last part, about 40 pages, treats of Geometry and Orthographic projection as applied to boiler-making.

The book is not very comprehensive, but practical men will find it useful.

A Text Book of Mechanical Engineering.

By Wilfred J. Lineham. 772 pp. 5¾x8 in. 732 Figs. and 18 folded Plates. Price, $4.50.

The author has here made the ambitious attempt of compressing into one volume the whole theory and practice of Mechanical Engineering. While this is manifestly impossible he has, nevertheless, made one excellent book which should be in the hands of every student of mechanical engineering and every mechanic engaged in the construction of machinery of any kind who aims to understand his business. It is divided into two main parts—Workshop Practice and Theory and Examples.

The headings of the chapters will give an idea of the scope of the book. There are: Part I.—Casting and Moulding; Pattern Making and Casting Design; Metallurgy and Properties of Materials; Smithing and Forging; Machine Tools; Marking-off, Machinery, Fitting, and Erecting; Boiler Making and Plate Work; Part II.—Strength of Materials, Structures and Machine Parts; On Energy, and the Transmission of Power to Machines; On Heat and Heat Engines and Hydraulics and Hydraulic Machines. The first part describes the processes and methods of doing work in the different shops. These descriptions are fuller and clearer than any that can be found elsewhere. Obviously, the author is a person who has had a great amount of experience in the doing of the things which he describes, but he is also what Herbert Spencer calls an excellent "expositor." The first part is descriptive only of the way work is done. In the latter part in the discussion of the theory of Mechanical Engineering, the subject to a great extent is treated mathematically, but, without some knowledge of algebra, a reader could not follow the explanations and demonstrations. The book is an excellent one and can be highly commended. The author is an Englishman, and all the illustrated methods and examples given are taken from English practice.

The Science of Mechanics; a Critical and Historical Exposition of its Principles.

By Dr. Ernst Mach. Translated from the German by Thomas J. McCormack. 534 pp. 5¾x7½ in. 235 Figs. Price, $2.50.

In this interesting treatise the author has written a history of the principles of mechanics, and as shown here these have been ascertained "from what sources they take their origin, and how far they can be regarded as permanent acquisitions."

In chapter I he shows the development of the Principles of Statics and begins with the Principle of the Lever and goes back to Archimede's time and shows from his writings what his conception of these principles was, and then, going on, shows how the theory of the lever was evolved successively by Galileo and others, down to modern times. The principles of the inclined Plane, composition of Forces, virtual velocities, etc., are all treated in a similar way. The book is an extremely interesting one, and the subjects are treated in an original way, and some of the illustrations and examples are very curious. Mathematics are, however, freely used in some of the explanations, and to read many of them understandingly, the reader must have some knowledge of calculus.

Any of the above books will be sent, prepaid, on receipt of the price, or information will be given, on application, with reference to the character and value of other books on mechanical engineering. Address, M. N. FORNEY, 47 Cedar Street, New York

steam. In this way the action of the spring will regulate the pressure of the steam in *B*, and the spring may be adjusted for any pressure by the nut *K*.

Heretofore there has been considerable difficulty in keeping double-seated valves similar to *e* and *g* steam tight. This difficulty, it is claimed by the Foster Company, is overcome by making the seat of the valve *e* of such an angle as will permit it to expand without forcing the disk *g* from its seat to any appreciable extent; and the angle of the lower seat is made more acute, so as to allow for the longitudinal expansion of the connecting spindle between the two disks *e* and *g*. The Foster Company have made a long series of experiments to determine the exact angles of these two seats in relation to the distance between the valves, and they claim to be able now to make an absolutely steam-tight double-seated valve.

A leak of the valves, unless so great as to exceed the demand for steam required, will not affect the operation of the regulator when there is a constant delivery; but if it is desired to shut off entirely the delivery of steam on the low-pressure side of the regulator, the valve must close off tight or the delivery pressure will accumulate until the full initial pressure is reached, which would cause an engine, when first started, to "race" until the excessive pressure in the low-pressure pipe was worked off; and if steam was being supplied to radiators, the accumulation might be a source of danger. To provide for leaks of this kind when it is required to shut off steam entirely, an adjustable relief valve is supplied which is connected with the space *B*.

If the spring or the diaphragm or any of their connections should be broken, the opening *E* may be closed by the screw *M*, and the escape of steam, excepting a very small quantity, be prevented, even though steam under pressure may be passing through the valves. By this means the defects may be repaired without stopping the engine or shutting off steam. Rapid or violent pulsations of the diaphragm may also be prevented by partially closing the screw *M* so as to allow only a small volume of steam to enter the chamber *D*, exactly as a steam-gauge is throttled to prevent the hand from vibrating.

Fig. 2 is a diagram taken by an Edson pressure-recording gauge from one of these regulators at the Western Union Telegraph dynamo room, with two and three engines in use. The upper heavy irregular line represents the variations in the boiler pressure, and the lower one the regulated pressure.

This new regulator is being operated as a pump governor with excellent results. In that service the steam port *E* is closed and connection made with the diaphragm chamber *D* from the discharge end of a pump. In operation, the discharge water pressure from the pump acts on the diaphragm instead of the st am, the pressure being regulated by the nut *K*. At the Clark Thread Works, Newark, N. J., it has been found that this valve controls the water pressure within 2 lbs. At the Gerry Building, in New York, water delivered into an open tank is kept within 2 in. of a given level. In this case a float valve is connected with discharge end of water pipe, and as the water rises the valve closes, thereby creating a pressure in the water pipe which, acting on the governor, stops the pump until the water level falls.

The manufacturers of this new device have recently been called on for a number of 4-in. and 6-in. valves to be used in connection with the evaporating plant on the American Liners *St. Louis* and *St. Paul*. These valves are to be placed between the evaporator, on which there is a steam pressure of 12 lbs. to 35 lbs. above the atmosphere, and the condenser, in which there is a vacuum of 12 lbs. below the atmosphere. This was at first regarded as a difficult problem for the reason, before explained, that there was a vacuum instead of pressure under the diaphragm, but it was finally solved by reversing the actuating powers, as shown in fig. 2—that is to say, the toggles *a a* were changed so that the power of the spring tended to close the valve. With this arrangement the normal position of the valves was shut; and when the vacuum in the condenser reached 12 lbs. below the atmosphere, the atmospheric pressure bearing on the *outside* of the diaphragm opened the valve, allowing the vapor to pass to the condenser. It was found that by a proper adjustment of the spring the requirements were met exactly.

The Foster Engineering Company, of Newark, N. J., are the manufacturers of these valves.

General Notes.

The Bucyrus Steam Shovel & Dredge Company announce through its receivers, Messrs. John S. George and Howard P. Eells, that, under the orders of the court, the business of the company will be prosecuted as usual. Existing contracts will be executed unless notice to the contrary shall be given, and orders for new machinery, repairs, supplies, etc., will be received on behalf of the receivers and promptly attended to. All supplies and material which may come in subsequent to this date will be for account of the receivers.

The Prentiss Tool & Supply Company have on hand at their salesrooms, 115 Liberty Street, New York City, a number of rare bargains in second-hand metal-working machinery, all first class, high-grade tools, many of which have never been used. All of them are as complete as when they left the factory, and many have chucks, tools and special attachments.

NEW TRAIN ON THE MONON ROUTE.

A MUCH-NEEDED want has been supplied by this popular line from Indianapolis. Train leaves at 7.30 A.M., arriving in Chicago at 12.59 P.M., returning at 4 58 P.M., reaching the former city at 11.00 P.M. This in addition to its previous excellent service places it ahead of all competitors.

MAP OF THE UNITED STATES.

A LARGE, handsome map of the United States, mounted and suitable for office or home use, is issued by the Burlington Route. Copies will be mailed to any address on receipt of 15 cents in postage by P. S. Eustis, General Passenger Agent, Chicago, Burlington & Quincy Railroad, Chicago, Ill.

THE PENNSYLVANIA RAILROAD

is favored with the patronage of the best class of travelers. Why?

Because, with complete protection by the block-signal, automatic and interlocking switches, and an unsurpassed road-bed, it is the safest.

Because, with a superb service of perfectly appointed trains, it is the most comfortable.

Because, with wise management and unlimited facilities, it is the promptest.

These reasons are heavy, and they tip the balance on the side of the "standard railway of America."

"BODY RESTED, MIND AT EASE."

That is what it is when travelling on the fast trains of the Chicago, Milwaukee & St. Paul Railway; besides there is no chance to "kick," for the accommodations are up to date, the trains keep moving right along and get there on time. These lines thoroughly cover the territory between Chicago, La Crosse, St. Paul, Minneapolis, Aberdeen, Mitchell, Sioux Falls, Sioux City, Yankton, Council Bluffs, Omaha and Northern Michigan. All the principal cities and towns in that territory are reached by the "St. Paul" lines, connecting at St. Paul, Council Bluffs and Omaha with all lines for points in the far west. Write to Geo. H. Heafford, General Passenger and Ticket Agent, Chicago, Ill., for one of their new map time tables and a brochure giving a description of the Compartment Sleeping Cars. Tickets furnished by any coupon ticket agent in the United States and Canada. The finest dining cars in the world are run on the solid vestibuled, electric-lighted and steam-heated trains of the Chicago, Milwaukee & St. Paul Railway.

OURSELVES AS OTHERS SEE US.

THE *Herald*, of Glasgow, Scotland, speaking of the "Four-Track Series"—the New York Central's guide-books—says:

"No effort is made in this country to produce railway guide-books that can compete with this series. The scope of the books gives every opportunity for the display of the varied charms of American scenery, there being views on the Hudson River, in the Adirondack Mountains and Catskills, on the St. Lawrence, Niagara Falls, etc. The great feature of the guides is the admirable pictures."

A copy of the illustrated catalogue containing a thorough review of the "Four-Track Series"—books, maps and etchings—will be sent free by mail, postpaid, to any address in the world, by George H. Daniels, General Passenger Agent, New York Central & Hudson River Railroad, Grand Central Station, New York.

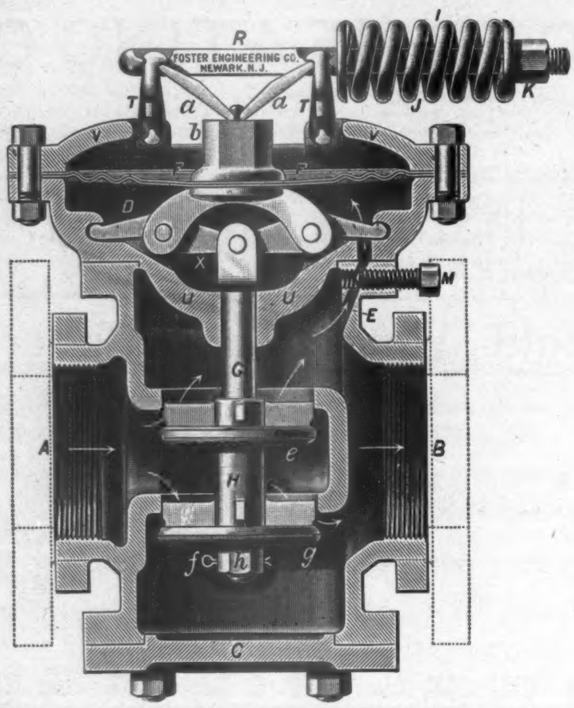
AMERICAN ENGINEER AND RAILROAD JOURNAL.

(Formerly the RAILROAD AND ENGINEERING JOURNAL.)

PUBLISHERS' DEPARTMENT.

FOSTER'S PRESSURE REGULATOR AND PUMP GOVERNOR: CORRECTION.

In the description of this device which was published last month the engraving herewith—through an error—was omitted, and should have been designated as fig. 1. The references to fig. 1 in that article were intended to apply to the engraving herewith, and not to the "vacuum regulator," which was erroneously designated as fig. 1. The description contained in the next to the last paragraph—published last month—refers to the *vacuum regulator*, which was there designated as fig 1,



FOSTER'S PRESSURE REGULATOR.

but in the rest of the description the *pressure regulator*—the engraving of which is published herewith—was referred to. As the parts in each are the same—excepting that the position of the toggles *a a* is reversed—and are designated by the same letters, perhaps the description was not entirely incomprehensible on account of our error, which occurred through the illness and absence from the office, when the proofs were received and read, of the author of the article.

General Notes.

The Sterlingworth Steel Body Bolster has, after a test, been ordered for 100 cars by the Central Railroad & Banking Company of Georgia, and will be manufactured for a term of years under contract with the Cambria Iron Company.

The Cotton States Exposition.—There are now about 500 men employed on the grounds of the Cotton States and International Exposition. It is expected that most of the buildings will be done by June 1.

The Youngstown Bridge Company have secured the contract for Hannah's Run Viaduct on the Cincinnati, Hamilton & Dayton Railway, and for two bridges on the Texas & Pacific Railway, including the tubular foundation work 55 ft. in depth.

The Wilmot & Hobbs Manufacturing Company, whose works at Bridgeport, Conn., were recently burned, will rebuild at once. In the mean while they will be able to fill all orders in the hot and cold-rolled steel business, since their hot-rolling mill plant is still intact.

The Manville Covering Company, of Milwaukee, Wis., and Norristown, Pa., are just completing a large contract with the State University, Madison, Wis.; the Union Stock Yards, St. Louis, Mo.; the Metropolitan Elevated Railroad, Chicago, Ill.; Helena Electric Light & Power Company, Helena, Mont.; Morgan Building, Buffalo, N. Y.; Jamestown Electric Light & Power Company, Jamestown, N. Y., and the Union Depot Railroad Company, St. Louis, Mo.

Leach's Sanding Apparatus.—Mr. Henry L. Leach reports having received orders for 47 sets of his sanding apparatus in February. In this list are included such roads as the Western New York & Pennsylvania, Southern Pacific, Louisville & Nashville, Central Railroad & Banking Company of Georgia, Boston & Albany, Lehigh Valley, Chesapeake & Ohio, etc.

The Penberthy Injector Company, of Detroit, Mich., report that their new line of water gauges, oil-cups, etc., is meeting with so great a success that they are several weeks behind their orders, and have been compelled to increase their force by putting on 10 additional men since January 1, and expect to make another increase in working force of about the same number in a few weeks.

The Richmond Compound Locomotive.—The experiments that have been made with the Richmond compound locomotive have given such good results on the Chesapeake & Ohio Railroad, that the management have decided to build an exceptionally heavy engine to haul the heavy fast passenger trains over the mountains between Charlottesville and Clifton Forge. It is the present intention to exhibit the engine at the Cotton States Exposition in the fall.

The Firm of Henry C. Ayer & Gleason Company has been dissolved by mutual consent. The manufacture of special tools for railway repair shops, a line of tools originally introduced by Henry C. Ayer, will be continued at his new location. As he is obliged to devote all of his time at the works, it has become necessary for him to relinquish his central office, No. 919 Betz Building. The business will be conducted under the name of Henry C. Ayer, Trenton Avenue Machine Works, southeast corner Trenton Avenue and Adams Street, Philadelphia, Pa.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

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PUBLISHERS' DEPARTMENT.

General Notes.

The Detroit Graphite Manufacturing Company have taken the contract for painting the viaduct of the Union Station-Association at Detroit, with their L. S. G. graphite paint. The structure was painted a short time since with the ordinary paint, but smoke and gases from the trains of the Michigan Central Railway, which pass under it, have about destroyed the paint, so that in order to preserve the metal the graphite paint is being applied. This is not affected by smoke.

The Cleveland Twist Drill Company are frequently in receipt of very complimentary notices regarding their twist drills. In one instance it was reported to them that two holes had been drilled in a 66-lbs. steel rail with two men in exactly four minutes, and that these drills frequently run through 100 holes without being sharpened—in one case 120 holes by accurate count being done without sharpening the drill. In this case the drills were run in one of their truck drills, which are operated by hand power.

The Rice & Sargent Engine Company, of Providence, R. I., report that during the month of March they have received three orders for steam-engines. One is a tandem-compound of 300 H.P., with cylinders 14 and 26 in. and a 42-in. stroke, independent condenser, to run at 100 revolutions a minute in the Pembroke Mills, Suncook, N. H. The Lawrence (Mass.) Lumber Company has ordered a 200 H.P. engine, 20 × 42, 80 revolutions, and the Oakdale Manufacturing Company, of Providence, a 75 H.P. engine, 12 × 30, 110 revolutions.

C. W. Hunt Company's system of narrow-gauge cars and track is now being installed by the Land Pebble Phosphate Company, of Florida, for handling their increased production of material by a more economical method. The land pebble phosphate of Florida occurs in a clay matrix containing on an average 25 per cent. of clear pebble and in strata having an average depth of 10 ft. This pebble phosphate, according to an analysis by Voelcher, contains and is equivalent to 79.19 per cent. tri basic phosphate of lime. The rapid growth of this industry is shown in the great increase of production since 1891. There was produced in 1891, 2,025 tons; in 1892, 17,795 tons, and in 1893, 62,281 tons.

M. T. Davidson, No. 77 Liberty Street, New York City, is building for the Johnson Company, Johnstown, Pa, for use in their Lorain, O., mills a pair of air pumps which are believed to be the largest ever constructed in this country. The apparatus in question consists of a pair of compound duplex air pumps arranged to run either singly or duplex; the dimensions are 16 in. diameter high-pressure steam cylinder, 30 in. diameter low-pressure by 36 in. diameter air cylinder by a common length of stroke of 24 in. There are two of these pumps, and each pair is provided with one jet condenser 6 ft. diameter by 12 ft. 9 in. high. The Davidson Works have just completed a pair of compound double plunger pumps for the same concern.

A New Car-Heater.—Mr. William C. Baker, the veteran car-heating engineer, has been engaged during the past winter in experimenting with a new form of heater with which he expects to dispense with fire or steam while the train is running, the heater being charged before the cars leave the station. With this object in view he has had constructed what may be called a full-sized model of a car-body on the roof of his shop in Hoboken. This he has equipped with his new apparatus, and has been testing it during the past winter. The apparatus consists of a receptacle or drum, it may be called, 20 in. in diameter and 8 ft. long, which is filled with pebbles, inside of which a coil of steam pipes is carried. Before the car leaves the station steam is passed through the pipes and heats the pebbles. These Mr. Baker feels confident will be capable of absorbing and storing sufficient heat to run a car from New York to Chicago or St. Louis without recharging. If this can be done it will certainly overcome many of the difficulties which are now with steam and other means and systems of heating.

Riehlé Brothers' Testing Machine Company, Philadelphia, have installed in their Department of Physical Tests several new testing machines which are of larger capacity than in any physical testing department, and of the latest improved designs. Tests are made daily and promptly at their works, Ninth Street, above Master, Philadelphia, and autographic strain diagrams furnished to those who desire. The following is a list of their equipments: 300,000-lb. vertical screw power testing machine "President"; 200,000-lb. vertical screw power testing machine "Schley"; Riehlé-Buzby automatic electric beam, as shown on 120,000-lb. vertical screw power testing machine (not illustrated in catalogue); 100,000-lb. vertical screw power testing machine "Philadelphia"; 100,000 lb. vertical screw power testing machine "Crown" with autographic attachment; 50,000-lb. testing machine "Vanderbilt"; Riehlé-Yale extensometer; Riehlé-Buzby hair-line extensometer; Riehlé-Boston micrometer gauge extensometer; Riehlé laying-off and per cent. gauge; Riehlé double-pointed center gauge; 40,000-lb. spring tester; 5,000-lb. Riehlé transverse tester "Waterloo"; 1,000-lb. cement testing machine, with W. R. C. grips; complete outfit of appliances for cement testing; 500-lb. Riehlé U. S standard cloth testing machine "Pitkin"; 100-lb. Riehlé U. S. standard paper tester "Weymouth"; hydrostatic pumps for bursting pressures of cylinders, pipes, etc.

The Forestry Exhibit at the Cotton States and International Exposition will be very complete. The forest resources will be shown, aside from maps and charts, and other graphic illustrations, as to their amount and distribution, by a series of 20 monographic displays, showing each one of the economically important tree species, which form the bulk of the lumber production of the South. Here will be seen, in monster frames, made of the trees themselves, a full description of the tree, in its foliage and fruit, its timber, its range of distribution, and all information desirable regarding the nature of the wood and its application in the arts.

To further illustrate the forest botany of the Southern States, sections of wood, with botanical specimens, and descriptive labels of more than 180 different kinds of Southern trees, will be displayed, not counting some 100 Florida and Texas species, which are of a semi-tropical character, so that the student of the flora of the South will find a rare chance for getting acquainted with its different arborescent features.

Russian Passenger Tariffs—The basis upon which the Russian passenger tariffs were originally established was that laid out by the regulations of the Grand Russian Railway Society. It was, for first class, 2.5 cents per mile; for second class, 1.9 cents per mile; and for third class, 1 cent per mile. This was the maximum charge that a company was allowed to make, but it was possible for it to charge less. It is hardly necessary to say that the companies did not avail themselves of the latter right, so their traffic developed very slowly. This development was still further checked by the imposition, in 1878, of a tax upon passenger tickets and upon fast freight trains. Each ticket was thus advanced 25 per cent. in price for the first and second classes, and 15 per cent. for the third class, while the freight rates for fast freight and the transportation of baggage was advanced subject to a tax of 25 per cent. The result was not unexpected; the number of passengers that had been slowly raised from 25 millions in 1876 to 30.3 millions in 1878, fell back to 29.8 millions in 1879. This is certainly very small for a population of 100,000,000 and a railway system of 17,000 miles. Furthermore, the greater portion of this traffic was of a local character. In order to increase the receipts, a new tariff was put in force on December 1, 1894, in which three kinds of tickets will be issued.

1. Tickets for frequent trips. These tickets bear the name of the starting and terminal points, with the price of the ticket, the time for which it is good, and the baggage charges.

2. Tickets for zones of less than 200 miles, bearing the names of 15 stations, with the prices and the charges for supplementary baggage. At the starting station the ticket agent cuts the ticket in such a way that the station to which it is good appears as the last of the list of stations on that portion of the ticket that is left in the hands of the passenger. These two kinds of tickets are printed on cardboard.

3. Tickets for other zones. These are printed on paper, and are composed of three parts. In the central part there is an enumeration of the zones, with the proper prices. The ticket agent retains the coupon, and that portion of the central part that contains the zones in the rear, so that the zone in which the journey is begun is at the head of the list, and this, together with the third part, remains in the hands of the passen

BOOKS FOR ENGINEERS AND MECHANICS.

The number of books, pamphlets and periodicals on engineering and mechanical subjects in existence, and which is published annually, is now so large that no engineer, mechanic or railroad employee can hope to read more than a very small fraction of them, and it is of the utmost importance that such persons should read only the best. Besides the really valuable books which are written by competent persons, who are experts in the subjects about which they have written, there is every year a large number of poor ones published which are written by more or less conceited or stupid incompetents, or by those whose only motive in writing is to make their names known, and such books it is, to a great extent, a waste of time to read and a waste of money to buy. This, as some one has written, "makes it extremely difficult for engineers, mechanics and railroad employees, anxious to keep themselves informed about their business, to know what it is really worth their while to read. They cannot read all that appears, for lack of time, and much of it is not worth reading; yet in the absence of capable criticisms of such works, they cannot easily learn what is really good."

These considerations, and the letters which an editor constantly receives enquiring about books and asking for information about them, has led me to conclude that it might be beneficial to many persons, especially to mechanics and others, whose information concerning the literature relating to their occupations is somewhat limited, and that it would be perfectly proper to recommend certain books which deserve recommendation, and give some information about their value and character. With this in view, the following notices of books have been prepared, and their value and character have been as well indicated as has been possible in such brief descriptions as are here given. These notices represent my own estimate of the character and value of the books to which they refer, and none will be noticed in this list, excepting those which can be recommended to readers, although it may be with some qualifications, as it is seldom that either books or people are altogether good. M. N. FORNEY.

Steam.

By WILLIAM RIPPER. 5×7½ in. 202 pp. Price, 80 Cents.

This is an elementary book on the steam engine, which is written very plainly, with no mathematical obscurities, and is an excellent work to put into the hands of a boy, apprentice, mechanic or other person as an introduction to this branch of engineering. It has the advantage of being brought up to a recent date, and is without the usual obsolete descriptions and illustrations often found in books on this subject.

The Steam Engine.

By GEORGE C. V. HOLMES. 5×7 in. 528 pp. Price, $2.00.

Is a more complete treatise on the steam engine than Ripper's book, and is also of recent date, and well up to modern practice. It is perhaps the best book on the general subject of the steam engine that a student, mechanic or young engineer can read. It is not very elaborately illustrated, but has 212 excellent wood cuts. It contains no mathematics more difficult than algebra, and not much of that. The science of heat and steam is treated in the earlier chapters, the theory of the steam engine follows. These are succeeded by descriptions of the mechanism of engines and boilers, and the concluding chapters are on compound engines. It does not relate especially to stationary, locomotive or marine engines, but the principles and construction of all these are discussed.

A Hand-Book of the Steam Engine.

By HERMAN HAEDER, C. E. 440 pp. 4¾×7 in. Price, $3.00.

The title page of this book—which is translated from the German—says that it has especial reference to small and medium-sized engines for the use of engine makers, mechanical draughtsmen, engineering students, and users of steam power. It is illustrated by over a thousand engravings showing the construction of stationary engines and their details. The general plan of the book is to show the construction of the engines and their parts by engravings and brief descriptions. Its defect is that the descriptions are often not full enough, and do not make the subject to which they relate entirely clear. The engines illustrated are chiefly of German construction, and for that reason, will have very great interest to American mechanics. The book contains little about the theory of the steam engine, and the only mathematics in it, are constructional calculations, and some algebra, but the latter is of a very simple kind, and there is not much of that. In studying the details of construction of small steam engines, this book will be an excellent aid, notwithstanding the defect referred to.

A Practical Treatise on the Steam Engine.

By ARTHUR RIGG. 379 pp. and 103 full-page plates 8½×11 in. Price, $10.00.

As the author says in his preface, "this treatise was written to describe various examples of fixed or stationary steam engines, without entering into the wide discussion of locomotive or marine practice; to give details of construction, with the principles by which their relative proportions may be calculated, and to investigate the more modern applications of science to the subject. In order to avoid mathematical forms of expressions which are unfamiliar to practical men, the graphic method of calculation is brought into prominent use." The book is probably the best and clearest treatise in the English language in what may be called the dynamics and kinematics of the steam engine, that is on the movement of the valves and their gearing, the action of the cranks, connecting rods and fly-wheels, the theory of governors, the influence of the velocity of reciprocating parts of steam engines and their operation. The chapter on the latter subject forms the clearest elucidation of it to be found anywhere. As stated in the preface most of the topics are explained graphically, the only mathematics in the book is a little elementary algebra.

The Catechism of the Locomotive.

By M. N. FORNEY. Second Edition. 709 pages 6×8 in., and six folded plates. Price, $3 50.

As its name implies, this book is written in the form of questions and answers, and as one of its reviewers said "is written on a low plane;" that is, the subjects to which it relates are explained in the simplest and clearest language that the author could command. As stated in the preface, his object in writing the book "was to furnish a clear and easily understood description of the principles, construction, and operation of the locomotive engine of the present day." There are but two mathematical elucidations in it, and they are in foot notes. It contains nearly 500 engravings which illustrate very fully, different classes of American locomotives and the construction of their parts. The principles and practice involved in these and in the operation of the whole machines are very fully explained, the aim being to make it "plain to plain people." At the same time, the subject was brought fully up to the practice which prevailed when this edition was first brought out, which was in 1889. The book is suited for engineers, mechanics, firemen, students, and, in short, any one who wants information about the principles and construction of the locomotive of the present day.

Compound Locomotives.

By PROF. ARTHUR TANNATT WOODS. Second edition revised and enlarged by David Leonard Barnes. 330 pp. 5¾×8¾ in. 166 engravings. Price, $3.00.

The purpose of this book is to give a description of the theory and construction of the Compound Locomotive in its most recent forms. This is admirably done and in a form so clear that it can be readily understood by any one at all acquainted with the subject of locomotive engineering. It is not an elementary book on the locomotive, but an explanation of compound locomotives for those who are acquainted with the principles and details of simple engines.

The Locomotive Engine and its Development.

Third Edition. By CLEMENT E. STRETTON, C. E. 240 pp., 7¼×5½, illustrated. Price, $1.00.

The sub-title of Mr. Stretton's book is "A Popular Treatise on the Gradual Improvements made in Railway Engines between the years 1803 and 1892." It is more properly a history of the development of the locomotive. It contains nearly 100 engravings of old and modern locomotives. Mr. Stretton has been an enthusiast in the study of the history of the locomotive, and has rescued from oblivion many facts which otherwise would have been forgotten. To a person interested in the subject, this little book will be as interesting as a novel, as it is written in a very simple style of narration of what the author has learned through his own investigation.

Locomotive Engine Running and Management.

Ninth Edition. By ANGUS SINCLAIR. 390 pp. 4⅞×7½ in. 36 engravings. Price, $2.00.

Mr. Sinclair describes his book as "A Treatise on Locomotive Engines, Showing their Performance in Running Different kinds of Trains with Economy and Dispatch; also Directions regarding the Care, Management, and Repairs of Locomotives and all their Connections." The book fulfills this description and also the author's intention, expressed in his preface, "to treat all subjects discussed in such a way that any reader would easily understand every sentence written. No attempt, he says further, "is made to convey instruction in anything beyond elementary problems in mechanical engineering, and all problems brought forward are treated in the simplest manner possible." It is intended primarily for locomotive engineers or runners and firemen, but incidentally will be very useful and instructive to locomotive superintendents, mechanics, and others who want information about the operation of locomotives. The language, explanations and directions are all admirably clear and easily understood.

The Construction of the Modern Locomotive.

By GEORGE HUGHES. 261 pp. 5½×8¾ in. 309 Figs. 3 folded plates. Price, $3.50.

As its title indicates, and as the author says, "design is not touched upon" in what he has written. "Each section," he says, "describes, step by step, more minutely, and by such drawings and illustrations as have not appeared before in one volume, the actual progress of the work done in that station." The author is an Englishman and describes how an English locomotive is built, or how the work is done in the boiler-shop, iron and brass foundries, the forge and "smithy," coppersmith's work, machine and erecting shops. The methods of doing work is illustrated by engravings from original drawings. American readers will be interested in some of the methods in use in British shops, which differ somewhat from American practice. The book is a good one, but considering what an excellent subject the author had, what he has written and published ought to have been better than it is.

A Manual of Marine Engineering.

By A. E. SEATON. 6×9 in. 459 pages. Price, $6.00.

This is a treatise on the designing, construction and working of marine machinery. The Author says in his preface that it "has been prepared to supply the existing want of a Manual showing the application of theoretical principles to the design and construction of marine machinery, as determined by the experience of leading engineers, and carried out in the most recent successful practice."

It is an elaborate treatise, and there is no book which is brought up more nearly to the most recent knowledge and practice in marine engineering than this is. It is not very fully illustrated, but has about 100 wood cuts. There is a liberal use of mathematics and the reader should be well up in algebra to read it with satisfaction. It treats of the principles of marine propulsion, principles of steam engineering, details of marine engineering, propellers, boilers and miscellaneous matters.

A Treatise on Steam Boilers.

By ROBERT WILSON. 4½×7 in. 328 pages. Price, $2.50.

This book is by a practical man, and is written so that any one can understand it easily. It has little or no mathematics, and few engravings, but is a very excellent treatise on a subject in the elucidation of which practical experience is of more value than scientific theories.

Boiler Makers' and Engineers' Reference Book.

By SAMUEL NICHOLLS. 5×7¼ in. 273 pages. Price, $2.50.

This theoretical and practical Reference Book contains a variety of useful information for employers of labor, firemen and working boiler-makers, iron, copper and tinsmiths, draftsmen, engineers, the general steam-using public, and for the use of science schools and classes. This volume belongs to the "practical" class of technical literature. It is intended to be a hand-book for all those who are engaged in the trade of boiler-making. The first 80 pages contain tables and other data which are found in nearly all engineer's pocket books. There are then about 150 pages devoted to the theories and practice of boiler-making. The last part, about 40 pages, treats of Geometry and Orthographic projection as applied to boiler-making.

The book is not very comprehensive, but practical men will find it useful.

A Text Book of Mechanical Engineering.

By WILFRED J. LINEHAM. 772 pp. 5¾×8 in. 732 Figs. and 18 folded Plates. Price, $4.50.

The author has here made the ambitious attempt of compressing into one volume the whole theory and practice of Mechanical Engineering. While this is manifestly impossible he has, nevertheless, made an excellent book which should be in the hands of every student of mechanical engineering and every mechanic engaged in the construction of machinery of any kind who aims to understand his business. It is divided into two main parts—Workshop Practice and Theory and Examples.

The headings of the chapters will give an idea of the scope of the book. There are: Part I.—Casting and Moulding; Pattern Making and Casting Design; Metallurgy and Properties of Materials; Smithing and Forging; Machine Tools; Marking-off, Machinery, Fitting, and Erecting; Boiler Making and Plate Work; Part II.—Strength of Materials, Structures and Machine Parts; On Energy, and the Transmission of Power to Machines; On Heat and Heat Engines and Hydraulics and Hydraulic Machines. The first part describes the processes and methods of doing work in the different shops. These descriptions are fuller and clearer than any that can be found elsewhere. Obviously, the author is a person who has had a great amount of experience in the doing of the things which he describes, but he is also what Herbert Spencer calls an excellent "expositor." The first part is descriptive only of the way work is done. In the latter part in the discussion of the theory of Mechanical Engineering, the subject to a great extent is treated mathematically, and, without some knowledge of algebra, a reader could not follow the explanations and demonstrations. The book is an excellent one and can be highly commended. The author is an Englishman, and all the illustrated methods and examples given are taken from English practice.

The Science of Mechanics; a Critical and Historical Exposition of its Principles.

By Dr. ERNST MACH. Translated from the German by Thomas J. McCormack. 534 pp. 5¾×7½ in. 235 Figs. Price, $2.50.

In this interesting treatise the author has written a history of the principles of mechanics, and has shown how these have been ascertained "from what sources they take their origin, and how far they can be regarded as permanent acquisitions."

In chapter I he shows the development of the Principles of Statics and begins with the Principle of the Lever and goes back to Archimede's time and shows from his writings what his conception of these principles was, and then, going on, shows how the theory of the lever was evolved successively by Galileo and others, down to modern times. The principles of the inclined Pl ne, composition of Forces, virtual velocities, etc., are all treated in a similar way. The book is an extremely interesting one, and the subjects are treated in an original manner, and some of the illustrations and examples are very curious. Mathematics are, however, freely used in some of the explanations, and to read many of them understandingly, the reader must have some knowledge of calculus.

ger. This third part is identical with the coupon and contains the station from which the journey is begun, the destination and the route that is to be followed.

It will be seen that the system is somewhat complicated, and it remains to be shown whether it will give satisfactory results. One thing is very certain, however, that it could hardly be adapted to the heavy traffic that is found on the lines of Western Europe. Baggage to the extent of 35 lbs is carried free, and the charge for supplementary baggage has been reduced 8 per cent. for runs of 200 miles and 38.9 per cent. for runs of 2,000 miles. So we here meet with conditions just the opposite to those that have obtained in Hungary, where the tariff has been so arranged as to encourage short distance travelling, while in Russia the attempt has been made to encourage the long distance travelling. It is true that before long it will not be 2,000 miles only that can be traversed on Russian territory, but 7,000 miles, when the Great Siberian Railroad is completed.—*Le Journal des Transports.*

The Consolidated Car-Heating Company, of Albany N. Y., have entered the field of steamship heating with their electrical heater. The regular form of street-car heater has been found to be well adapted for this purpose, and they are now in communication with a large number of steamship companies with a view to its introduction. They also report that they have received in competition with other manufacturers an order for electrical heaters for 149 cars for the West End Railway of Boston, and also for 300 cars for the People's Construction Company, of Philadelphia, and 187 for the Union Railroad of Providence, 60 for the Nassau Road in Brooklyn, and other smaller orders. They have also taken orders for supplying the Commingler Storage System and Sewall steam coupler to the equipment of the Norfolk & Western Railroad, and the Ulster & Delaware Railroad with the direct steam system No. 2, and the Sewall steam coupler. These orders include the equipment of all locomotives of both roads. The company has contracted recently for an extension of their factory, which will nearly double their capacity.

The Link-Belt Machinery Company, Chicago, has just completed for the C. C. Washburn Flouring Mill Company, Minneapolis, Minn., the machinery for a 1,200-H.P. rope transmission. The motive power is a large triple-expansion engine, made in Germany and exhibited at the World's Fair. To this is coupled a steel shaft 31 ft. long, in two pieces, 11½ in. in diameter, swelled to 15 in. to receive the fly-wheel, which is 14 ft. in diameter, with 20 grooves for 2 in. rope, and weighs 38,000 lbs. This shaft is supported in pillow blocks on heavy cast-iron sole plates set on stone foundations. From the fly-wheel power is transmitted to a sheave 10 ft. 8 in. in diameter, having 20 grooves for 2-in. rope and weighing 21,500 lbs. There is a single idler of the same diameter running loose on each side of it, leading the rope off to the tension carriages. This driven sheave is put on a cast-steel quill 15 in. in diameter, weighing 4,000 lbs., which runs on its own bearings. The mill shaft passes through this quill and receives power from it by means of a pair of flanged faced couplings. The bearings for the quill are set on cast-iron pedestals 5 ft. high. Each pedestal and pillow block weighs 7,700 lbs. Two tension carriages with 7-ft. sheaves and 3,600 ft. of 2-in. special red thread manilla transmission rope complete the drive.

The Boston Belting Company.—For the following interesting history of this Company we are indebted to the Boston *Herald:*

"The manufacture of rubber was first started in Roxbury (now a part of Boston), by the Roxbury Rubber Company in 1828. During the year 1842 Mr. John Haskins, the Manager of the Company, made the acquaintance of Mr. Charles Goodyear (who was then engaged in the manufacture of pocket-books in Philadelphia) at a hotel in New York City, and to him he explained the difficulties under which his Company was laboring on account of not being able to preserve the rubber goods for any great length of time after they were made.

"Mr. Goodyear was much interested, and soon after made a visit to the factory at Roxbury. Later on he gave up his business at Philadelphia and came to Boston to see if he could discover the long-desired process of curing rubber so it would not stiffen with cold, or soften or decompose with heat. After a long series of experiments, Mr. Goodyear discovered that the use of artificial heat applied to rubber compounds containing sulphur would produce the desired result, and soon after purchased from Mr. Daniel Hayward his patent for the use of sulphur in rubber compounds, and then applied for a patent for the use of sulphur and artificial heat, which was allowed June 15, 1844.

"The name of the Roxbury Rubber Company was soon after changed to the Goodyear Manufacturing Company, and so continued until the following year, 1845, when the name was changed to the Boston Belting Company. The manufacture of rubber goods of all kinds was perfected at the factories of the Company, and, in 1846, rights to manufacture rubber boots, shoes, clothing, hard rubber goods, etc., were sold, and other companies were then formed for the manufacture of these articles. The Boston Belting Company retained the exclusive right to manufacture all kinds of mechanical rubber goods, such as belting, hose, packing, springs, valves, printers' blankets, deckle straps, billiard cushions, tubing, etc. The business of the Boston Belting Company steadily increased, the factory buildings have long since covered about 3 acres of land, and employment is given to more than 500 men. The capital of the Company has been increased from time to time, until it now has a paid-up capital of $1,000,000, with a surplus of about $600,000.

"The principal store and office is at 256, 258 and 260 Devonshire Street, Boston, with a branch store at 100 Chambers Street, New York.

The Foster Engineering Company, of Newark, N. J., report that among recent orders received for their pressure regulators to be applied to dynamo engines are two 4-in. for the United States battleship *Texas,* one 5-in for the United States armored cruiser *Brooklyn,* one 3-in. and one 4-in. for the United States armored cruiser *Indiana,* five 7-in. for the Providence Steam Engine Company, two 8-in. for the Corliss Engine Company of Providence, and one 4-in. for the Western Union Telegraph Company's building. The latter is to deliver steam to three dynamo engines, and to meet specifications is required to maintain within 1 lb. a uniform delivery pressure of 45 lbs. regardless of change of initial or boiler pressure, which ranges from 60 to 100 lbs., and regardless of change of load or number of engines in operation. The company has entered an order for the Messrs. Cramp & Sons for the equipment for the great American liner *St. Louis* with their Foster pressure regulators. The order for immediate requirements includes six 8-in., which are the largest valves the Foster Company have ever made for steamship service, eight 5-in., and others of smaller sizes.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

(Formerly the RAILROAD AND ENGINEERING JOURNAL.)

PUBLISHERS' DEPARTMENT.

MALLEABLE IRON CARLINE AND SILL POCKETS.

It is well known that in the framing of freight cars the strength of important members of the structure is reduced considerably by the material which must be removed for mortises and tenons. This method of framing also makes it difficult to remove any single member of the car frame for the purpose of making repairs. These objectionable features are avoided by the malleable iron carline and sill pockets which the National Malleable Castings Company is making under patents controlled by Mr. W. E. Coffin, of Marshall, Tex. Views of these pockets are shown in fig. 1 of the accompanying illustrations, the lower view showing several of them of different sizes attached to a side plate and with the ends of the carlines in place. The intermediate view shows the same pockets with the carlines removed, and the upper view shows the plate and carline ends drilled and ready to be put together. In fig. 2 are shown pieces of freight-car plates and carlines, which illustrate in a striking manner the way in which the parts are weakened by the present method of framing.

The advantages of these carline and sill pockets will be readily appreciated by all practical car-builders, and may be summed up as follows: They save the time and expense of mortising and tenoning timbers, and also reduce the cost of erecting the framework of a car, and the sills and plates are not weakened as in the present construction. The time required in renewing end or side plates, carlines, or sills, is greatly reduced, as by removing the bolts which hold the carline or sill pocket a timber can be removed without spreading the frame or disturbing the adjacent parts. They are made in all sizes and shapes by the National Malleable Castings Company, from whom further information may be obtained by applying to the office of the railway department of the Company, 1525 Old Colony Building, Chicago.

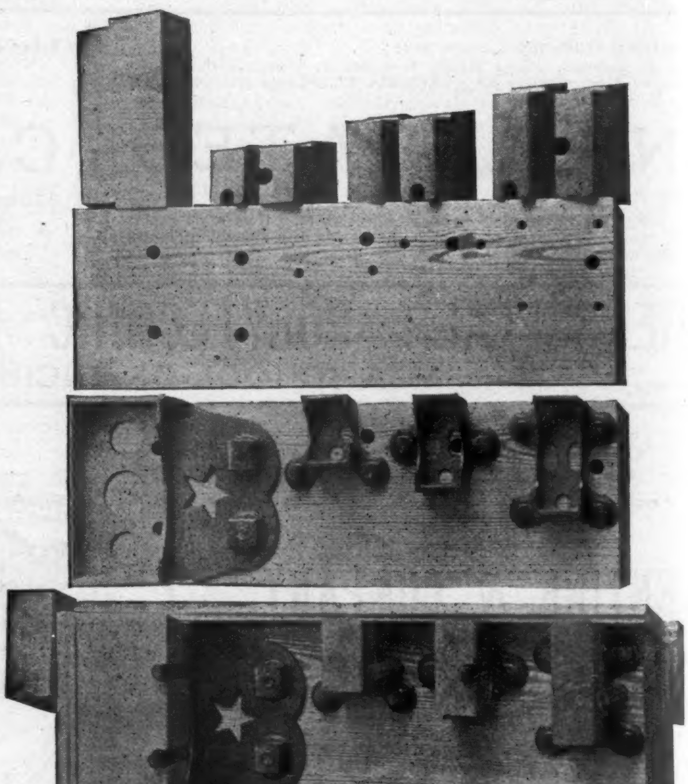

Fig. 1.—MALLEABLE CARLINE AND SILL POCKET.

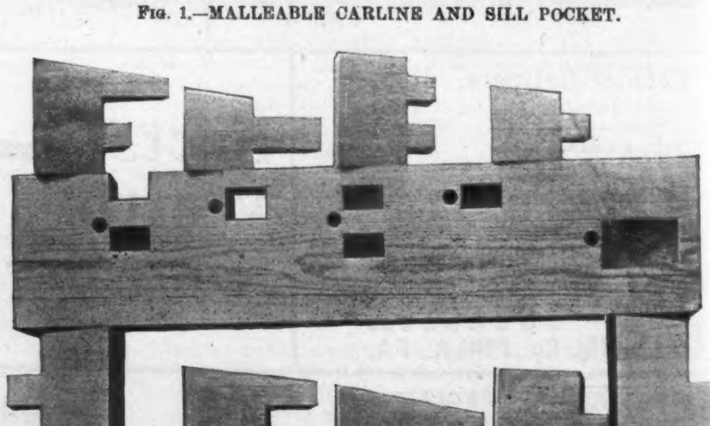

Fig. 2.—MORTISE AND TENONS IN FREIGHT-CAR PLATES AND CARLINES.

General Notes.

The Brady Metal Company, 115 Broadway, New York, report increased demands for their well-known Magnus metals. Several new contracts have just been closed with prominent railways. Magnus is now in service on nine of the fastest passenger trains run in America.

The Deepest Mining Shaft in the World.—What is said to be the deepest mining shaft in the world has reached the copper lode in shaft No. 3 in the Tamarack Mine, at Opeechee, Mich. This is now a trifle over 4,200 ft. in depth, was begun three years ago, and reached the vein at a depth of 4,185 ft.

The Youngstown Bridge Company have been awarded the contract for a six-span bridge at Clarksville, Ark.; a bar mill building for the Ohio Steel Company; a mill building 85 × 200 ft. in New York; and the South Street Bridge, at Warren, O., consisting of three 70-ft. girder spans.

Cleveland Twist Drill Company, of Cleveland, O., have received the following award for their exhibit at the World's Fair: "Most extensive exhibit and greatest variety of well-made twist drills, exhibited as they are manufactured and furnished to the trade. The workmanship on all of these drills is of the highest order, and especially meritorious are the twist drills in millimeter diameters."

The Sterlingworth Railway Supply Company have placed their brake beams and steel body bolsters on the following roads: Toledo, St. Louis & Terre Haute; Burlington, Cedar Rapids & Northern; Delaware, Lackawanna & Western; Central Railroad of Georgia; Maine Central; New York, Ontario & Western; Mather Stock Car Company; Cold Blast Transportation Company; Fitchburg; Fall Brook; Georgia Southern & Florida; Atlanta & West Point, etc. Their orders aggregate many thousands of beams and bolsters.

The Richmond Locomotive Works, of Richmond, Va., have engaged space for an exhibit of their rolling stock in the Transportation Building of the Cotton States and International Exposition. They will place on exhibition two of their finest locomotives.

A number of trains of the finest cars ever made will be displayed by various railroad companies in the large annex to the Transportation Building, and the exhibit of engines will be particularly fine.

BOOKS FOR ENGINEERS AND MECHANICS.

The number of books, pamphlets and periodicals on engineering and mechanical subjects in existence, and which is published annually, is now so large that no engineer, mechanic or railroad employee can hope to read more than a very small fraction of them, and it is of the utmost importance that such persons should read only the best. Besides the really valuable books which are written by competent persons, who are experts in the subjects about which they have written, there is every year a large number of poor ones published which are written by more or less conceited or stupid incompetents, or by those whose only motive in writing is to make their names known, and such books it is, to a great extent, a waste of time to read and a waste of money to buy. This, as some one has written, "makes it extremely difficult for engineers, mechanics and railroad employees, anxious to keep themselves informed about their business, to know what it is really worth their while to read. They cannot read all that appears, for lack of time, and much of it is not worth reading; yet in the absence of capable criticisms of such works, they cannot easily learn what is really good."

These considerations, and the letters which an editor constantly receives enquiring about books and asking for information about them, has led me to conclude that it might be beneficial to many persons, especially to mechanics and others, whose information concerning the literature relating to their occupations is somewhat limited, and that it would be perfectly proper to recommend certain books which deserve recommendation, and give some information about their value and character. With this in view, the following notices of books have been prepared, and their value and character have been as well indicated as has been possible in such brief descriptions as are here given. These notices represent my own estimate of the character and value of the books to which they refer, and none will be noticed in this list, excepting those which can be recommended to readers, although it may be with some qualifications, as it is seldom that either books or people are altogether good. M. N. FORNEY.

Steam.

By WILLIAM RIPPER. 5×7½ in. 202 pp. Price, 80 Cents.

This is an elementary book on the steam engine, which is written very plainly, with no mathematical obscurities, and is an excellent work to put into the hands of a boy, apprentice, mechanic or other person as an introduction to this branch of engineering. It has the advantage of being brought up to a recent date, and is without the usual obsolete descriptions and illustrations often found in books on this subject.

The Steam Engine.

By GEORGE C. V. HOLMES. 5×7 in. 528 pp. Price, $2.00.

Is a more complete treatise on the steam engine than Ripper's book, and is also of recent date, and well up to modern practice. It is perhaps the best book on the general subject of the steam engine that a student, mechanic or young engineer can read. It is not very elaborately illustrated, but has 212 excellent wood cuts. It contains no mathematics more difficult than algebra, and not much of that. The science of heat and steam is treated in the earlier chapters, the theory of the steam engine follows. These are succeeded by descriptions of the mechanism of engines and boilers, and the concluding chapters are on compound engines. It does not relate especially to stationary, locomotive or marine engines, but the principles and construction of all these are discussed.

A Hand-Book of the Steam Engine.

By HERMAN HAEDER, C. E. 440 pp. 4¾×7 in. Price, $3.00.

The title page of this book—which is translated from the German—says that it has especial reference to small and medium-sized engines for the use of engine makers, mechanical draughtsmen, engineering students, and users of steam power. It is illustrated by over a thousand engravings showing the construction of stationary engines and their details. The general plan of the book is to show the construction of the engines and their parts by engravings and brief descriptions. Its defect is that the descriptions are often not full enough, and do not make the subject to which they relate entirely clear. The engines illustrated are chiefly of German construction, and for that reason, will have very great interest to American mechanics. The book contains little about the theory of the steam engine, and the only mathematics in it, are constructional calculations, and some algebra, but the latter is of a very simple kind, and there is not much of that. In studying the details of construction of small steam engines, this book will be an excellent aid, notwithstanding the defect referred to.

A Practical Treatise on the Steam Engine.

By ARTHUR RIGG. 379 pp. and 103 full-page plates 8½×11 in. Price, $10.00.

As the author says in his preface, "this treatise was written to describe various examples of fixed or stationary steam engines, without entering into the wide discussion of locomotive or marine practice; to give details of construction, with the principles by which their relative proportions may be calculated, and to investigate the more modern applications of science to the subject. In order to avoid mathematical forms of expressions which are unfamiliar to practical men, the graphic method of calculation is brought into prominent use." The book is probably the best and clearest treatise in the English language in what may be called the dynamics and kinematics of the steam engine, that is on the movement of the valves and their gearing, the action of the cranks, connecting rods and fly-wheels, the theory of governors, the influence of the velocity of reciprocating parts of steam engines and their operation. The chapter on the latter subject forms the clearest elucidation of it to be found anywhere. As stated in the preface most of the topics are explained graphically, the only mathematics in the book is a little elementary algebra.

The Catechism of the Locomotive.

By M. N. FORNEY. Second Edition. 709 pages 6×8 in., and six folded plates. Price, $3.50.

As its name implies, this book is written in the form of questions and answers, and as one of its reviewers said "is written on a low plane;" that is, the subjects to which it relates are explained in the simplest and clearest language that the author could command. As stated in the preface, his object in writing the book "was to furnish a clear and easily understood description of the principles, construction, and operation of the locomotive engine of the present day." There are but two mathematical elucidations in it, and they are in foot notes. It contains nearly 500 engravings which illustrate very fully, different classes of American locomotives and the construction of their parts. The principles and practice involved in these and in the operation of the whole machines are very fully explained, the aim being to make it "plain to plain people." At the same time, the subject was brought fully up to the practice which prevailed when this edition was first brought out, which was in 1889. The book is suited for engineers, mechanics, firemen, students, and, in short, any one who wants information about the principles and construction of the locomotive of the present day.

Compound Locomotives.

By PROF. ARTHUR TANNATT WOODS. Second edition revised and enlarged by David Leonard Barnes. 330 pp. 5¾×8¾ in. 166 engravings. Price, $3.00.

The purpose of this book is to give a description of the theory and construction of the Compound Locomotive in its most recent forms. This is admirably done and in a form so clear that it can be readily understood by any one at all acquainted with the subject of locomotive engineering. It is not an elementary book on the locomotive, but an explanation of compound locomotives for those who are acquainted with the principles and details of simple engines.

The Locomotive Engine and its Development.

Third Edition. By CLEMENT E. STRETTON, C. E. 240 pp., 7¼×5¼, illustrated. Price, $1.00.

The sub-title of Mr. Stretton's book is "A Popular Treatise on the Gradual Improvements made in Railway Engines between the years 1803 and 1892." It is more properly a history of the development of the locomotive. It contains nearly 100 engravings of old and modern locomotives. Mr. Stretton has been an enthusiast in the study of the history of the locomotive, and has rescued from oblivion many facts which otherwise would have been forgotten. To a person interested in the subject, this little book will be as interesting as a novel, as it is written in a very simple style of narration of what the author has learned through his own investigation.

Locomotive Engine Running and Management.

Ninth Edition. By ANGUS SINCLAIR. 390 pp. 4⅞×7⅛ in. 36 engravings. Price, $2.00.

Mr. Sinclair describes his book as "A Treatise on Locomotive Engines, Showing their Performance in Running Different kinds of Trains with Economy and Dispatch; also Directions regarding the Care, Management, and Repairs of Locomotives and all their Connections." The book fulfills this description and also the author's intention, expressed in his preface, "to treat all subjects discussed in such a way that any reader would easily understand every sentence written. No attempt, he says further, "is made to convey instruction in anything beyond elementary problems in mechanical engineering, and all problems brought forward are treated in the simplest manner possible." It is intended primarily for locomotive engineers or runners and firemen, but incidentally will be very useful and instructive to locomotive superintendents, mechanics, and others who want information about the operation of locomotives. The language, explanations and directions are all admirably clear and easily understood.

The Construction of the Modern Locomotive.

By GEORGE HUGHES. 261 pp. 5½×8¾ in. 309 Figs. 3 folded plates. Price, $3.50.

As its title indicates, and as the author says, "design is not touched upon" in what he has written. "Each section," he says, "describes, step by step, more minutely, and by such drawings and illustrations as have not appeared before in one volume, the actual progress of the work done in that station." The author is an Englishman and describes how an English locomotive is built, or how the work is done in the boiler-shop, iron and brass foundries, the forge and "smithy," coppersmith's work, machine and erecting shops. The methods of doing work is illustrated by engravings from original drawings. American readers will be interested in some of the methods in use in British shops, which differ somewhat from American practice. The book is a good one, but considering what an excellent subject the author had, what he has written and published ought to have been better than it is.

A Manual of Marine Engineering.

By A. E. SEATON. 6×9 in. 459 pages. Price, $6.00.

This is a treatise on the designing, construction and working of marine machinery. The Author says in his preface that it "has been prepared to supply the existing want of a Manual showing the application of theoretical principles to the design and construction of marine machinery, as determined by the experience of leading engineers, and carried out in the most recent successful practice."

It is an elaborate treatise, and there is no book which is brought up more nearly to the most recent knowledge and practice in marine engineering than this is. It is not very fully illustrated, but has about 100 wood cuts. There is a liberal use of mathematics and the reader should be well up in algebra to read it with satisfaction. It treats of the principles of marine propulsion, principles of steam engineering, details of marine engineering, propellers, boilers and miscellaneous matters.

A Treatise on Steam Boilers.

By ROBERT WILSON. 4½×7 in. 328 pages. Price, $2.50.

This book is by a practical man, and is written so that any one can understand it easily. It has little or no mathematics, and few engravings, but is a very excellent treatise on a subject in the elucidation of which practical experience is of more value than scientific theories.

Boiler Makers' and Engineers' Reference Book.

By SAMUEL NICHOLLS. 5×7¼ in. 273 pages. Price, $2.50.

This theoretical and practical Reference Book contains a variety of useful information for employers of labor, firemen and working boiler-makers, iron, copper and tinsmiths, draftsmen, engineers, the general steam-using public, and for the use of science schools and classes. This volume belongs to the "practical" class of technical literature. It is intended to be a hand-book for all those who are engaged in the trade of boiler-making. The first 80 pages contain tables and other data which are found in nearly all engineer's pocket books. There are then about 150 pages devoted to the theories and practice of boiler-making. The last part, about 40 pages, treats of Geometry and Orthographic projection as applied to boiler-making.

The book is not very comprehensive, but practical men will find it useful.

A Text Book of Mechanical Engineering.

By WILFRED J. LINEHAM. 772 pp. 5¾×8 in. 732 Figs. and 18 folded Plates. Price, $4.50.

The author has here made the ambitious attempt of compressing into one volume the whole theory and practice of Mechanical Engineering. While this is manifestly impossible he has, nevertheless, made an excellent book which should be in the hands of every student of mechanical engineering and every mechanic engaged in the construction of machinery of any kind who aims to understand his business. It is divided into two main parts—Workshop Practice and Theory and Examples.

The headings of the chapters will give an idea of the scope of the book. There are: Part I.—Casting and Moulding; Pattern Making and Casting Design; Metallurgy and Properties of Materials; Smithing and Forging; Machine Tools; Marking-off, Machinery, Fitting, and Erecting; Boiler Making and Plate Work; Part II.—Strength of Materials, Structures and Machine Parts; On Energy, and the Transmission of Power to Machines; On Heat and Heat Engines and Hydraulics and Hydraulic Machines. The first part describes the processes and methods of doing work in the different shops. These descriptions are fuller and clearer than any that can be found elsewhere. Obviously, the author is a person who has had a great amount of experience in the doing of the things which he describes, but he is also what Herbert Spencer calls an excellent "expositor." The first part is descriptive only of the way work is done. In the latter part in the discussion of the theory of Mechanical Engineering, the subject to a great extent is treated mathematically, and, without some knowledge of algebra, a reader could not follow the explanations and demonstrations. The book is an excellent one and can be highly commended. The author is an Englishman, and all the illustrated methods and examples given are taken from English practice.

The Science of Mechanics; a Critical and Historical Exposition of its Principles.

By DR. ERNST MACH. Translated from the German by Thomas J. McCormack. 534 pp. 5¼×7½ in. 235 Figs. Price, $2.50.

In this interesting treatise the author has written a history of the principles of mechanics, and has shown how these have been ascertained "from what sources they take their origin, and how far they can be regarded as permanent acquisitions."

In chapter I he shows the development of the Principles of Statics and begins with the Principle of the Lever and goes back to Archimede's time and shows from his writings what his conception of these principles was, and then, going on, shows how the theory of the lever was evolved successively by Galileo and others, down to modern times. The principles of the inclined Plane, composition of Forces, virtual velocities, etc., are all treated in a similar way. The book is an extremely interesting one, and the subjects are treated in an original manner, and some of the illustrations and examples are very curious. Mathematics are, however, freely used in some of the explanations, and to read many of them understandingly, the reader must have some knowledge of calculus.

Any of the above books will be sent, prepaid, on receipt of the price, or information will be given, on application, with reference to the character and value of other books on mechanical engineering. Address, M. N. FORNEY, 47 Cedar Street, New York.

The Locomotive Coaling Station of the Philadelphia & Reading Railroad serves 126 locomotives. The total amount of coal delivered daily to these locomotives is 395 tons, and at this station the locomotives take coal, sand and water, and dump ashes. The coal, sand and ashes are carried from the hoppers beneath the track to storage bins above by the C. W. Hunt Company's conveyor. The coal is delivered to the locomotive through revolving chutes which measure a certain amount of coal at each revolution.

Mechanical Expert and Solicitor of Patents.—Mr. R. C. Wright, who was formerly engaged with the Baldwin Locomotive Works, and later in preparing the exhibit of the Baltimore & Ohio Railroad at the Columbian Exposition, announces that he has established an office in Philadelphia as an expert and solicitor of patents in the line of steam engineering, locomotive and car construction, together with general railroad work, wood and iron-working and hoisting machinery. His long experience as a designer of railroad machinery eminently qualifies him for the work which he is now undertaking. He has associated with himself Mr. F. E. Stebbins, of Washington, who for a number of years was an examiner in the United States Patent Office, and also with Mark Wilks Collet, a well-known patent lawyer. The new combination offer special advantages to inventors and would-be patentees. Mr. Wright's office will be at 906 Walnut Street, Philadelphia, Pa.

The Cincinnati Screw & Tap Company, manufacturers of set and cap screws, semi-finished, finished, and case-hardened hexagon nuts, and all kinds of small work turned, stamped, and milled, from steel, iron, and brass wire or sheet, have issued a very compact catalogue bound in cloth, and it will be of interest and value to all users of this class of goods to have one for reference. In addition to their own manufactures they have the agencies to Brown & Sharpe Manufacturing Company's milling cutters, Cleveland Rubber Company's belting, packing, and hose, Hoyt's pure, oak-tanned, short-lap leather belting, the Benjamin Atha & Illingworth Company's "Champion Extra" tool steel and open-hearth machinery steel. They also supply high-grade round, square, and hexagon iron. It will be noticed that they have the agencies of some of the best concerns in the country, and goods of their own manufacture are second to none in the country.

New Steel Plant of the Ohio Steel Company.—The steel output of the country will be largely augmented as soon as the plant of the Ohio Steel Company, at Youngstown, O., is put into operation, which will probably be during the present season. The plant, which has been designed throughout by Mr. Julian Kennedy, M.E., of Pittsburgh, Pa., is a notable one in many respects. The buildings have been designed especially for the purpose, and are in every way well arranged for the manufacture of steel. There are some 15 or 20 separate buildings, of which the Youngstown Bridge Company, of Youngstown, O., built the larger number, including the cranes and other riveted work about the works. The building which we illustrate is the pit furnace building, which is 54 ft. × 175 ft. and 44 ft. high to the square. The crane girders are supported by separate columns along either side of the building, which will carry traveling cranes to serve the entire building. The structure is covered with corrugated iron, No. 18 gauge on the roof and No. 22 on the sides. The building was just completed by the Youngstown Bridge Company, who are now erecting the mill building, 420 ft. long.

The Westinghouse Machine Company's New Shop.—Contracts have been let and ground broken for the Westinghouse Machine Company's new shops at East Pittsburgh. A few years ago the Westinghouse Air Brake Company erected large shops at a point on the main line of the Pennsylvania Railroad, about 12 miles from Union Station, Pittsburgh, where the town of Wilmerding was laid out and built. The location at East Pittsburgh of the Westinghouse Electric & Manufacturing Company's immense plant, and the Fuel Gas & Manufacturing Company's factory, to be followed now by the removal of the Westinghouse Machine Company to the same place, will form, with the Union Switch & Signal Company's works at Swissvale, a concentration of Westinghouse interests, practically at one point, within a half hour's ride of the city. The main building of the Westinghouse Machine Company's new shops will be 602 ft. × 230 ft. The construction throughout will be as nearly fireproof as modern building methods can devise. To meet this proposition, the specifications call for a steel structure with brick walls, slate roofs, wire-glass skylights, etc. A building of similar construction, 200 ft. × 60 ft., will contain the hammer shop and power plant. Within the main building, through which switches are run direct from the main line of the Pennsylvania Railroad, will be the machine shop, erecting shop, foundry, pattern shop, warehouse, offices, etc. Two crane runways, each 60 ft. span, on which electric cranes of the latest improved design will be used, extend the length of the building. The remaining space is taken up with galleries provided with lighter crane service. The present equipment of machine tools will be increased by the addition of whatever is best to facilitate the manufacture and handling of the company's enormous product. The hammer shop will have every convenience that the best shop practice can suggest for doing work thoroughly and expeditiously. It will be equipped with one 8-ton, one 3-ton, one 2-ton, and several smaller hammers, besides the usual cranes, etc. It is estimated that the cost of the buildings alone will reach $400,000. The contracts call for completion on November 1, 1895.

The Almy Water-tube Boiler Company, of Providence, R. I., are now building the following marine boilers: For the Bath Iron Works, of Bath, Me., two, with a combined capacity of 1,000 H.P., for the steam yacht now building for R. H. White, of Boston, and two, with a combined capacity of 600 H.P., for the passenger boat running between Portland and Booth Bay. Two for the Crescent Ship Yard, of Elizabethport, N. J., 700 H.P., for the first steam yacht built at these yards since Mr. Louis Nixon leased them. One for steam yacht *Adelita*, of Boston, 350 H.P., N. C. Nash owner. One for the George Lawley & Sons' Corporation, South Boston, of 450 H.P., for the yacht now building for George Drexel, of Philadelphia. One for L. H. Tillinghast's steam yacht *Aida*, of this city, 200 H.P. One for C. A. Henry, of the Canadian Pacific Railroad, for his steam yacht on the St. Lawrence River, 80 H.P. One now ready for delivery for George Vanderbilt's steam yacht *Lucille*, 140 H.P., which is now in winter quarters at Bowdoinham, Me. This yacht is used by Mr. Vanderbilt principally at Bar Harbor. Also one for the Crane Manufacturing Company, of Lakeport, N. H., for their steam launch for use upon Lake Winnipesaukee. They also delivered in March, boilers for three small passenger steamers now building for the Pennsylvania Railroad, and one for a steam yacht now building at the Atlantic Works, East Boston, for Henry E. Converse.

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JUNE, 1895.

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RAILROAD SUPPLIES.
Chester Steel Castings Co., Chester, Pa.
Crane Co., Chicago, Ill.
Q. & C. Co.

R. R. AND SPECIAL TRUCKS.
Whiting Foundry & Equipment Co., 235 Dearborn St., Chicago, Ill.
Riehle Bros.' Testing Mach. Co., 9th St., above Master, Philadelphia, Pa.

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Frick Company, Waynesboro, Pa.

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U. S. Metallic Packing Co., 435 No. Broad St., Philadelphia, Pa.

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Crosby Steam Gage & Valve Co., Boston Mass.

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Correspondence School of Industrial Science, Scranton, Pa.

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Folsom Snow Guard Co., 33 Lincoln St., Boston, Mass.

SNOW PLOWS.
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J. T. Connelly, Milton, Pa.
Stow Flexible Shaft Co., Binghamton, N.Y.

STEAM ENGINES & BOILERS.
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Frick Co., Waynesboro, Pa.
H. J. McKeown, 196 E. Front St., Cincinnati, O.
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STEAM HAMMERS.
Bell Steam Engine Co., Buffalo, N. Y.
Cleveland Ship Building Co., Cleveland, O.
Bement, Miles & Co., Philadelphia, Pa.
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STEAM PUMPS.
Blake, Geo. F. Mfg. Co., 95 Liberty St., N.Y.
Davidson, M. T., 43 Keap St., Brooklyn, N.Y.
Dean Bros. Steam Pump Works, Indianapolis, Ind.

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Chester Steel Castings Co., Chester, Pa.
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Pittsburgh Crushed Steel Co., Pittsburgh, Pa.

STEEL FORGINGS.
Bethlehem Iron Co., So. Bethlehem, Pa.
Cambria Iron Co., 218 So. Fourth St., Philadelphia, Pa.
Pennsylvania Steel Co., 208 So. Fourth St., Philadelphia, Pa.

STEEL RAILS.
Bethlehem Iron Co., So. Bethlehem, Pa.
Cambria Iron Co., 218 So. Fourth St., Philadelphia, Pa.
Dudley, P. H., 80 Pine St., New York.
Pennsylvania Steel Co., 208 So. Fourth St., Philadelphia, Pa.

STEEL TIES.
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Latrobe Steel Works, Latrobe, Pa.

STEEL-TIRED WHEELS.
Allen Paper Car Wheel Co., Chicago, Ill.
Ramapo Wheel & F'y Co., Ramapo, N. Y.
A. Whitney & Sons, Philadelphia, Pa.

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TAPS AND DIES.
Armstrong Mfg. Co., Bridgeport, Conn.
Jarecki Mfg. Co., Erie, Pa.

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Rensselaer Polytechnic Inst., Troy, N. Y.
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Hunt & Clapp, 116 Water St., Pittsburg, Pa.
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Riehlé Bros.' Testing Mach. Co., 9th St., above Master, Philadelphia, Pa.
Wm. Sellers & Co., Philadelphia, Pa.

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Wm. Sellers & Co., Philadelphia, Pa.
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VARNISH.
Pratt & Lambert, 47 John St., New York

VISES.
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Almy Water-tube Boiler Co. Providence, R
Boyer's Sons, L., 90 Wall St., New York
Finlayson Water-Tube Boiler Co., P. Box 128 Detroit, Mich.
Mosher, C. D., 1 Broadway, New York
Moyes, L. M., 411 Walnut St., Philadelphia, Pa.
Robert Poole & Son Co., Baltimore, Md

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Trenton Iron Co., Trenton, N. J.

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Jarecki Mfg. Co., Erie, Pa.

WROUGHT IRON CASTINGS.
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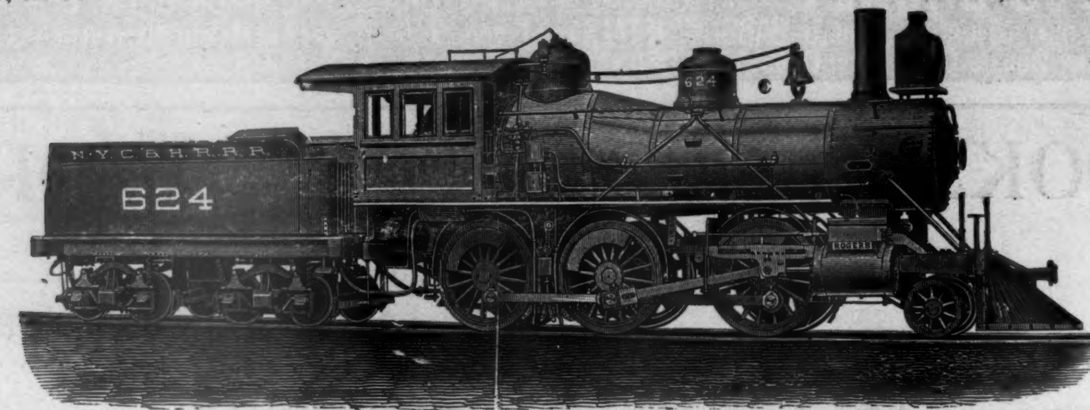
ALPHABETICAL INDEX TO ADVERTISERS.

ROGERS LOCOMOTIVE COMPANY,

PATERSON, N. J. **NEW YORK OFFICE, 44 Exchange Place**



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R. S. HUGHES, President. *G. S. LONGBOTTOM, Sec'y.* *G. E. HANNAH, Treas.* *REUBEN WELLS, Supt.*

ESTABLISHED 1865.

Richmond Locomotive and Machine Works,

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LOCOMOTIVES FOR EVERY SERVICE.

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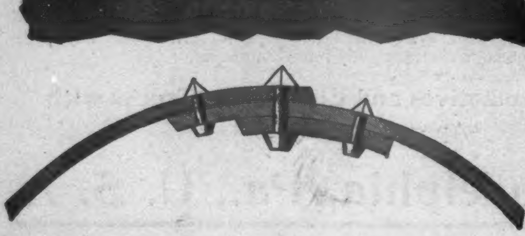

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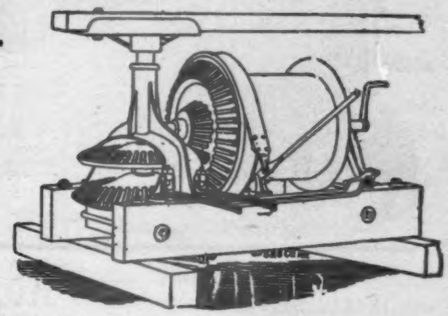

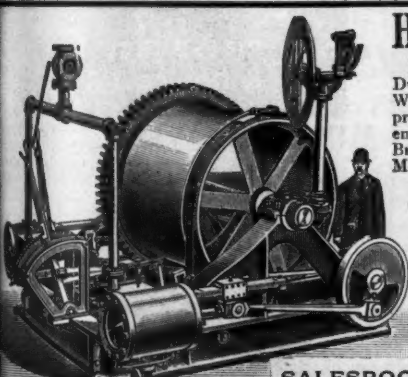

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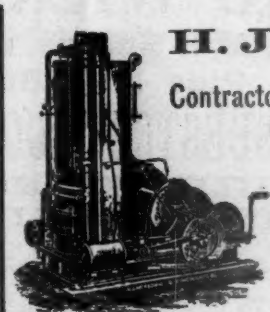

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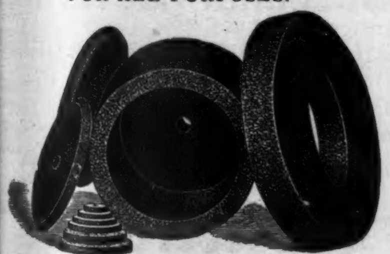

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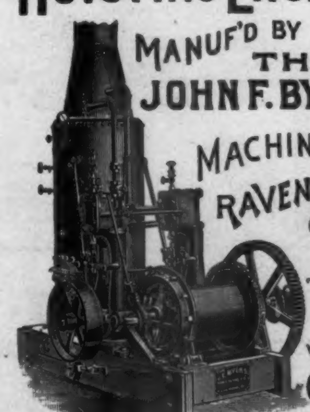

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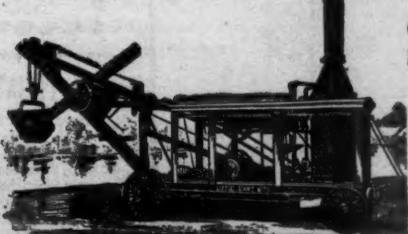

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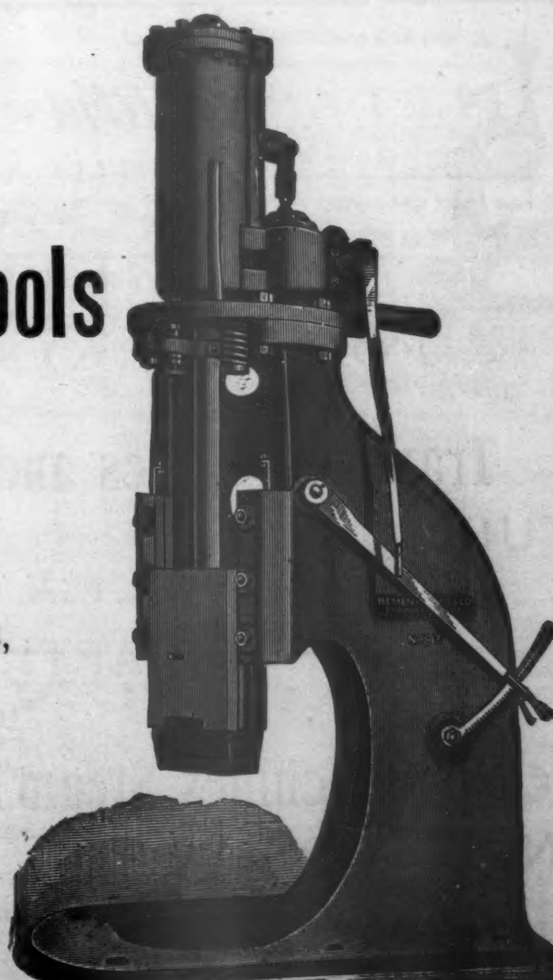

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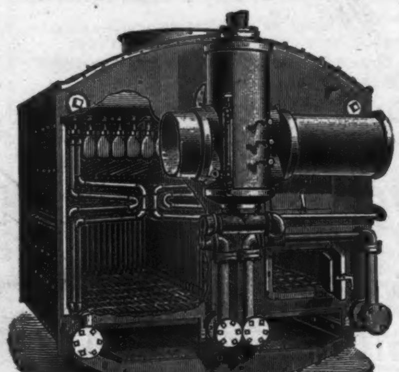

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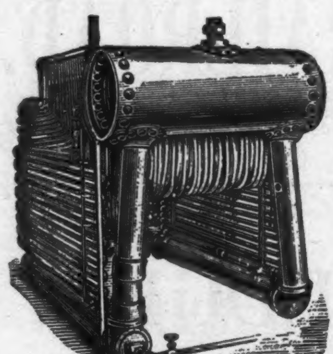

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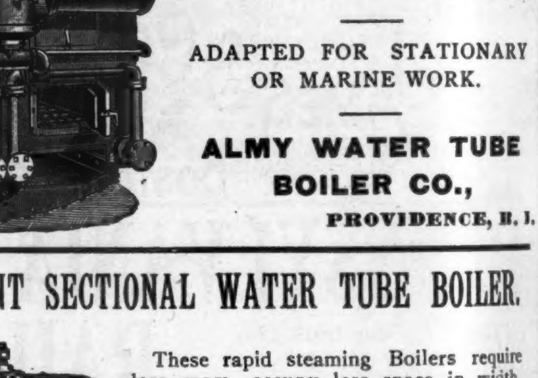

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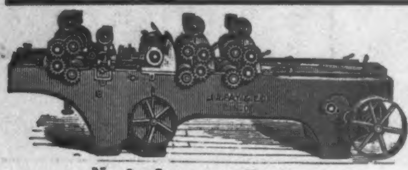

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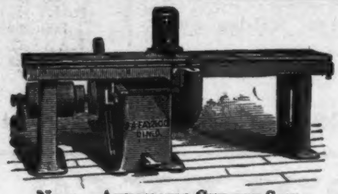

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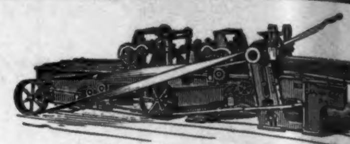

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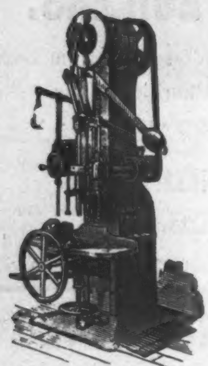

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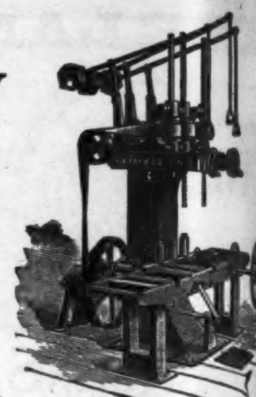

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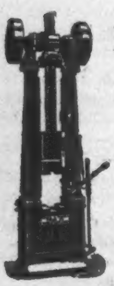

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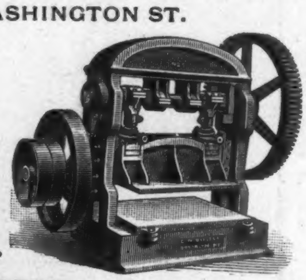

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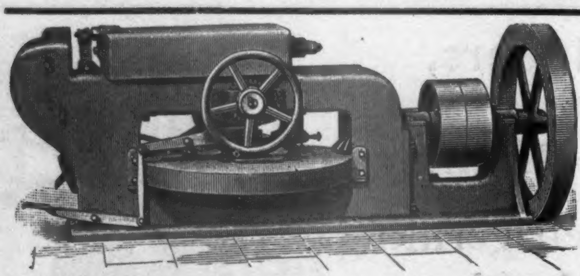

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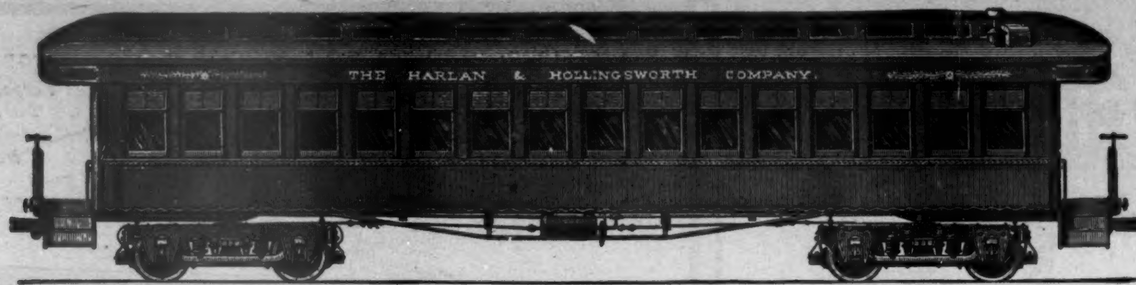

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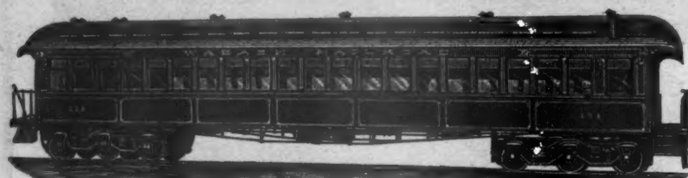

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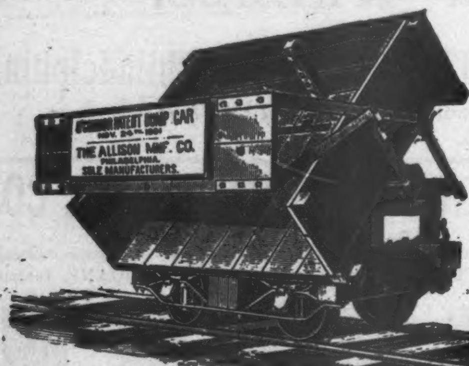

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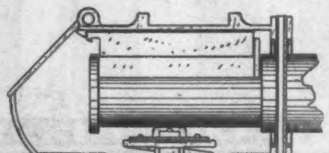

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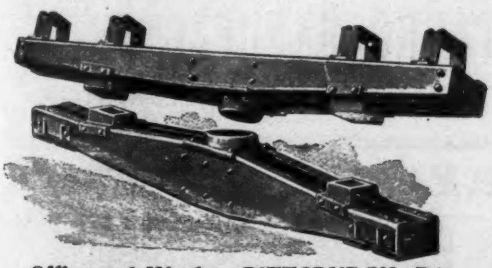

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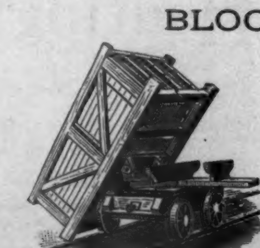

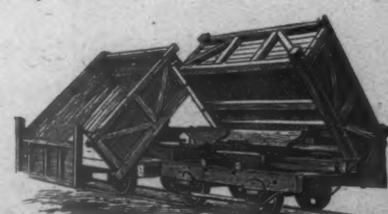

MANUFACTURERS OF

FLAT CARS, SIDE and ROTARY DUMP CARS,

Built Especially for Contractors, with or without Steel Linings.